Petroleum Processing

PETROLEUM REFINING | PETROCHEMICAL MANUFACTURING | GAS LIQUIDS RECOVERY

NOVEMBER, 1955

CONSTANT INSPECTION — a 'must' in fighting waste and pollution — p. 1744

NEW THIS MONTH — helpful process data you can clip and file . . . . p. 1745

SIX METAL FAILURE PROBLEMS — and why they happened . . . . . p. 1729

FOR BETTER CATALYST LOSS DATA — try radioactive tracers . . . . . p. 1718

A McGRAW-HILL PUBLICATION

Solo-aire units condense and cool three streams from a refinery process unit

SERVICE NUMBER ONE

Mixed steam and hydrocarbon vapor condenser and cooler.

Gravity	47° API
Inlet Temperature	340° F
Outlet Temperature	140° F
Heat Removed	19,500,000 BTU/hr.

SERVICE NUMBER TWO

Mixed steam and hydrocarbon vapor condenser and cooler.

Gravity	31° API
Inlet Temperature	463° F
Outlet Temperature	135° F
Heat Removed	34,100,000 BTU/hr.

SERVICE NUMBER THREE

Hydrocarbon liquid cooler.

Gravity	43° API
Inlet Temperature	430° F
Outlet Temperature	130° F
Heat Removed	10,000,000 BTU/hr.

If water rather than air were used as a cooling medium for these services, about 4500 gallons per minute would have been required.

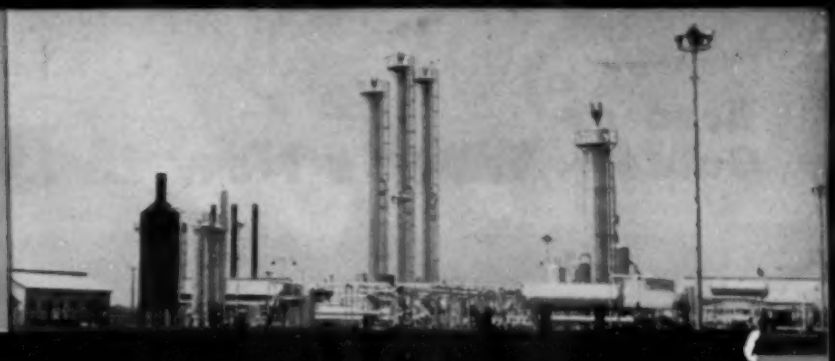
These Hudson Solo-aires are operating with complete satisfaction in one of the world's major oil refineries. They were designed and built to rigid specifications for oil refinery service including API-ASME Code for pressure parts, explosion proof motor drives, and corrosion resistant structural steel parts, and were specially designed to fit into a congested area.

In addition to Solo-aires Hudson manufactures the COMBIN-AIRE unit, which uses a combination of air and water for cooling, and also cooling towers for conventional cooling of water.

HUDSON
ENGINEERING CORPORATION

FAIRVIEW STATION • HOUSTON, TEXAS

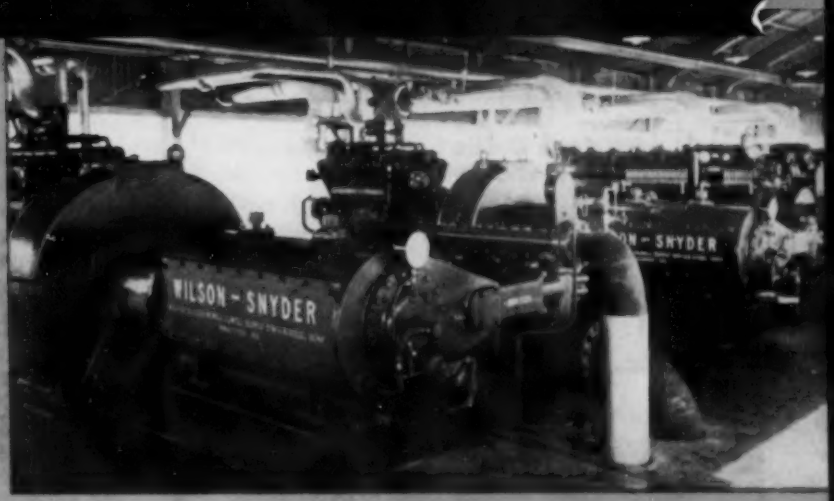
In the R. R. Dean Processing Plant near Agua Dulce, Texas



Quintuplex Plunger Pumps

. . . recycle lean oil in the absorption process at

HIGH PRESSURE



ENGINEERING, design, and construction of this plant were performed by O. L. Olsen Company of Houston, Texas for the Tennessee Production Company.

It was designed to process 100,000,000 cubic feet of gas per day, "floating" on Tennessee Gas Transmission Company's line pressure of 800 pounds; total plant pressure drop 8 pounds.

In the absorption process, two No. 558-P Wilson-Snyder Quintuplex Plunger Pumps recycle lean oil after it is refrigerated to 50 degrees F. Equipped with hardened steel plungers, heat-treated stainless-steel wing-guided valves and seats and driven through speed reducers by 340-hp Le Roi gas engines, each pump is capable of delivering 510 gpm at 1270 psi.

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Reader's Guide What's New in Petroleum

IT'S NEW

Your "Clip-n-File" Process Data Sheet

A new feature this month—and every month from now on—this three-page, fold-out data sheet has been designed for your convenience. It is perforated—so you can remove it quickly and neatly. Use it to build up your own personal process manual. This month's subject is:

Ethylene Oxide by Direct Air Oxidation of Ethylene

. . . a process aimed at high product purity, good product yields at low operating cost and low raw materials costs. **p. 1765**

II 2 3

IT'S NEW

Readers Guide to Departments

To help you find your favorite among the twelve regular monthly departments in the "back of the magazine," your "Readers' Guide to Departments, a new feature starting with this issue. . . **p. 1759**

Featured this month:

Cut condenser tube failures, one of several helpful tips in Plant Practices.

New ultrasonic flowmeter for weight or volume, one of over 50 ideas in What's New.

Glad you're an oil man? The November Editorial points up some good reasons why.

The Southwest Will Stay Dominant

. . . in petrochemicals from natural gas. Favorable plant locations, coupled with an ample supply of raw materials, will continue to favor this region in the future growth of the industry, for some time to come, by V. B. Guthrie. **p. 1711**

I II III 2 3 5

You Need Good Electrical Design

Natural gasoline plants today are big investments. They use few operators and are frequently far from cities and towns. Continuous, trouble-free operation is a must, and good electrical design can go a long way toward giving it to you. **p. 1715**

III 2 3

For Better Catalyst Loss Studies

. . . in Fluid catalytic cracking units, you'll want to read how The Texas Co. uses the radioactive cobalt tracer technique to uncover some previously unknown pieces of information, by A. J. Kinsella, Jr., and J. J. Mitchell. **p. 1718**

I 1 2 3

Choosing a Pulsation Dampener?

An essential part of your compressor plant design to minimize pipe-damaging and meter accuracy-smashing vibrations. Which of the four basic types is best for you? The advantages and disadvantages of each one. **p. 1724**

II III 2 3

A McGRAW-HILL PUBLICATION

ABP ABC

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Processing for November, 1955

PETROLEUM REFINING I | PETROCHEMICAL MANUFACTURING II | GAS LIQUIDS RECOVERY III | RESEARCH & DEVELOPMENT 1 | DESIGN & ENGINEERING 2 | PLANT OPERATION 3 | MAINTENANCE & CONSTRUCTION 4 | MANAGEMENT & PERSONNEL 5

A Pattern for Purity

"No smog—no pollution—no odors." In its appeal to win Hawaiian approval for construction, that's how California Standard has described the 25,000 b/d refinery it proposes to build for $30,000,000 in the harbor at Honolulu. **p. 1726**

I 2 3 4 5

Significant Trends in Control

A clearly-developed outline of instrumentation in the petroleum processing industries—its yesterday, its today, and its probable tomorrow. **p. 1740**

I II III 2 3 5

Is Metal Failure Your Problem?

The cause may be stress due to temperature gradient. Here's a helpful explanation of how and when it occurs, and it effects, by D. J. Bergman, who also presents:

Six specific problems, and their solutions

1 – Bulged spools in catalytic cracking units.
2 – Tube distortion in a thermal cracking unit.
3 – Bowed bars in a pressure vessel liner.
4 – Stresses at non-compatible metal junctions.
5 – Rupture due to vapor barrier in insulation.
6 – Bulged coker and distorted support pieces.

p. 1729

I II III 2 3 4

Want to Cut Waste AND Pollution?

Here's a picture story on Esso Standard Oil Co.'s four-way attack on this problem at Baton Rouge, La., using (1) equipment, (2) constant inspection, (3) publicity, and (4) training. **p. 1744**

I 3 4 5

A Safer Flash Point Elevator

Are you investigating methylene chloride? Here are flash and fire points for six different groups of methylene chloride-flammable solvent systems, including aliphatics, aromatics, alcohols, ketones, esters, and miscellaneous solvents, by J. J. De Voldre and M. J. Skrypa. **p. 1746**

I II 1 2

Processing by Means of Radiation?

The "electron gun," another new approach, is being used by Atlantic Refining Co. Activity is growing fast. Seven petroleum companies now are researching in this field. **p. 1738**

I II III 1 5

Improve Your Fractionator Control

For natural gasoline or petrochemical separations, it will pay you to investigate the differential refractometer. How it works, where it's used, selecting the proper system, training and maintenance needs. **p. 1750**

I III 2 3 4

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Continue "Readers' Guide" on p. 1759

HOW TO USE IT:

Your new "Reader's Guide to What's New in PETROLEUM PROCESSING" will do two things for you. First, the key numbers with each article will tell you at a glance if it is within your scope of interest; Roman Numerals indicate industries; Arabic Numerals, fields of activity. Second, the longer descriptions will tell you what each article is about, and why it can be of help and interest to you. —THE EDITORS

today's most complete *advanced design*

- **863 Models** in three Basic Pressure Groups.
- **Capacities** from 2 cc. per hour to 15,000 gal. per hour.
- **Pressures** to 50,000 psi.
- **Mediums Handled.** Any liquid that will flow to the Pump—clear free-flowing, viscous, tarry materials and slurries—corrosive mediums such as acids, alkalies, salts, oxidizing and reducing agents, etc.
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- **Metering Accuracy** to two-tenths of one percent with automatic control mechanisms.

Now, no matter what your chemical proportioning problem—you will find the answer at PHILADELPHIA PUMP, "headquarters" for the most complete line of Controlled Capacity Pumps.

Advanced Design Offers Savings In First Cost and Maintenance

Pump users actually wrote the specifications for PHILADELPHIA PUMPS. For their design is the result of an industry-wide survey of pump users' practical experience on "what is wrong with the proportioning pumps you are using."

Simplification and standardization of basic features, and more efficient production methods, have answered the first complaint—High First Cost. Model for model, PHILADELPHIA PUMPS are lower in price.

Prevalent points of failure—cross-heads, connecting rod bearings, pressed valve seats, packing, etc.—have been corrected through advanced design and better materials of construction.

High Maintenance Costs—excessive down time and labor—have been eliminated by a design which permits the removal of all moving parts and packing through the oversize cross-head without breaking piping connections.

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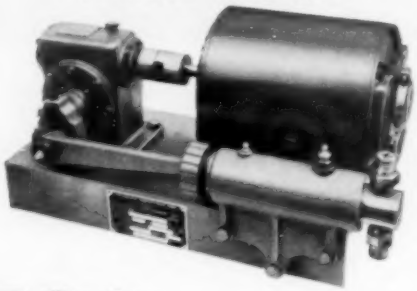
Repeat orders testify to user satisfaction, and it is significant that engineers who know pumps best, men who purchase quantities of them annually for some of the largest plants—prefer PHILADELPHIA PUMPS.

It will pay you to investigate. Write for catalog.

Pressures to **800** psi

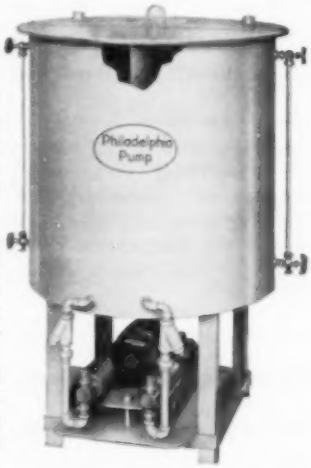


LP Series

The Phila-Feeder controlled capacity Proportioning Pump—a low cost, high quality pump popular for feeding water treating chemicals into steam boilers. Made in simplex and duplex types for maximum capacity to 18 gph. Adaptable to manual or automatic control.

Packaged Chemical Feed Units

PHILADELPHIA PUMP offers many standard and special designs of self-contained Units to meet all chemical feed requirements.



Unit illustrated is for feeding water treating chemicals. It comprises welded steel storage tank, Phila-Feeder duplex pump and all necessary auxiliaries and piping ready to connect to chemical feed piping and electrical circuits.

Other special Chemical Feed Units developed by PHILADELPHIA PUMP include:

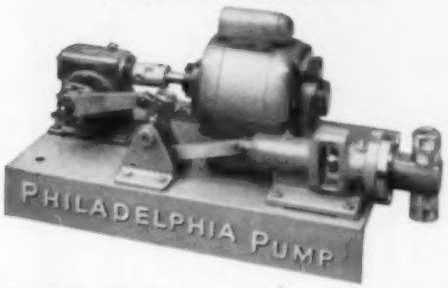
- Oil Well Chemical Treating Systems
- Natural Gas Odorizing Units
- Special Chemical Mixing & Proportioning Units

• *Sales Engineers in principal industrial centers in the United States, Canada, Mexico, and abroad.*

PHILADELPHIA

line of proportioning pumps

Pressures to **1500** psi

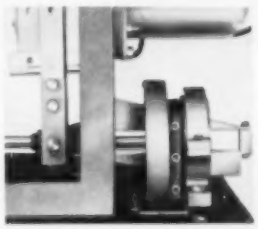


S Series

Made in simplex and duplex types for maximum capacity to 3300 gph. The standard proportioning pumps for most Processing Industry requirements and for treating of boiler water, municipal and industrial water, and sewage.

The pump illustrated is equipped with rocker-arm micro-adjustment of pump capacity while running.

The PHILATROL Automatic Control



This patented control mechanism for exceedingly accurate proportioning in relation to any meterable factor, adjusts piston stroke and hence pump capacity in response to manual, hydraulic, pneumatic or electrical motivation. It permits continuous stepless adjustment from zero to maximum and eliminates the "hunting" characteristics of other mechanisms with coarser adjustments.

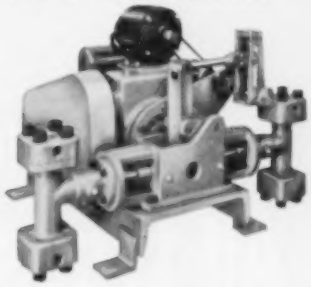
Illustrated is Philatrol Mechanism installed with air actuator on PHILADELPHIA PUMP used in gas odorizing. This pump has maintained metering accuracy within plus or minus two-tenths of one percent.

The UNI-FEEDER Automatic Control

Uni-Feeder single-revolution-clutch operated PHILADELPHIA PUMPS inject one or as many as 72 or more measured slugs of fluid per minute according to a time cycle or flow, color, concentration, or any other meterable factor.

Uni-Feeder Pumps are available with minimum capacities from .000093 gallons to maximum capacities of 27 gallons per minute.

Pressures to **50,000** psi



HP Series

These PHILADELPHIA PUMPS, designed for higher viscosities and pressures, are available in simplex, duplex and quadruplex types and in capacities from 2 cc. to 15,000 gph.

Like all PHILADELPHIA PUMPS, they are adaptable to both manual and automatic control of capacity.

The design of these pumps offers mechanical advantages which permit reduction in horsepower normally required by as much as 30 percent.

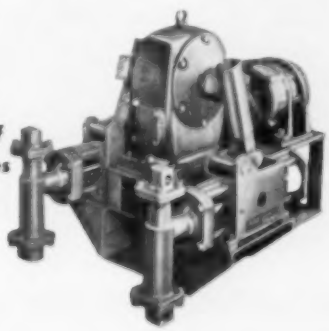
Differential Pressure Pumps

PHILADELPHIA PUMPS of the HP Series also offer a design feature which permits them to utilize the energy incorporated in any suction pressure to decrease the amount of horsepower required to produce the desired discharge pressure.

For example, if suction pressure is 2000 psi and discharge pressure is 3000 psi, the pump requires powering only for the differential pressure of 1000 psi, plus a small addition for friction losses. Consequently, great savings in first cost (motor, gear reducer, etc.) and operating cost can be effected.

See Our Exhibit at the 25th Exposition of Chemical Industries

December 5-9 1955



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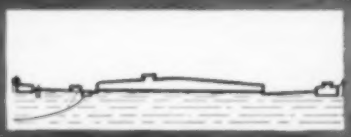
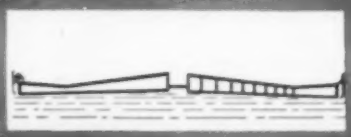


WIGGINS LODEK*

Designed so that the underside is in complete contact with the liquid surface. No vapor space can exist beneath the floating roof. Especially recommended where corrosive products are stored.



WIGGINS DOUBLEDEK*

If you prefer a double-deck roof choose the best—the new Wiggins Doubledek. Complete drainage design and between-deck accessibility add up to unmatched efficiency and safety.

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*patented

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Petroleum Processing

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A "Make-It-Yourself" Process Handbook

THERE'S something new in this issue of PETROLEUM PROCESSING which I think you'll find interesting and worthwhile, particularly if you're a "do-it-yourself" addict. It's our new "Process Data Sheet" —facing pg. 1762.

This department will be a regular item in PETROLEUM PROCESSING from now on. Every month we'll give you a flow chart and technical data on one particular process—refining, petrochemical, gas liquids recovery. The processes to be described may not always be brand, spanking new ones, but they'll be of current interest and significance—and the descriptions will give current, up-to-date information on them.

We've done several things in the mechanics of presenting this new "Process Data Sheet" to make it a more helpful tool for you. First, it's in the form of a fold-out, nearly three times as wide as our regular pages. That extra wide "screen," plus a quick-reading, outline form of presentation, make it possible for us to give you all the pertinent, essential data for a process on a single sheet right in front of your eyes. No more turning back and forth from one page to another or hunting through paragraphs of solid text to find the morsel of information you want.

Second, we've perforated the sheet along the inside edge so that you can remove it from the issue, punch it for binding, and build up your own personal, up-to-date process handbook. We've also printed it on heavier stock than we use for the bulk of the magazine to give you something that will hold up under frequent usage.

You're probably asking yourself by now: "What's the good of these sheets? All that stuff's available in the literature." And so a good deal of it might be. But who has all the literature at his fingertips? And who hasn't often wished there were some easy way to keep a petroleum processing textbook up-to-date?

I think these "Process Data Sheets" are something you'll want to keep—and suggest you start saving them right now, with this very first one. Over a period of time, they'll give you a quick, compact reference to all the major processes.

Now there's one thing I'd like to ask from you. Drop me a card or note, and tell me what specific processes you'd like to see covered in these "Process Data Sheets." And let me know what particular type of data you'd like to see included. These sheets are for your use—and we want to make them do a job for you.

William F. Bland

—Editor

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The monthly magazine of oil marketing—news, prices, transportation, storage merchandising

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What's Happening

in Refining

. . . **ASTM has approved** the following changes in the minimum research octane number for gasoline, both Types A and B, under Specification D 439-54T: for regular grade 82 min.; and for premium grade 89 min. Changes will appear in 1955 edition of Committee D-2's standards later this winter.

. . . **Office of Defense Mobilization** has taken these actions: reopened and boosted expansion goal for petroleum refining capacity to 9,000,000 b/d by Jan. 1, 1957—a 250,000 b/d increase; raised alkylates goal by an additional 25,000 b/d; expanded propylene derived glycerin program by 70,000,000 lb/yr.

. . . **ODM also granted** Certificates of Necessity to these companies for new construction:

Sunray Oil Corp. for a 1,340 b/d natural gasoline plant in Acadia Parish, La.; **Utah Oil Refining Co.** for a 5,500 b/sd fixed-bed Ultraformer at Salt Lake City; **Petrolite Corp.** for an electric de-salting plant to process 11,000 b/d of crude at Texas Co.'s El Paso refinery; **Sunray Mid-Continent Oil Co.** for a 140,000 mcf/d natural gas plant in San Patricio County, Texas; **Carter Oil Co.** for a 2,500 b/d hydrofiner and other facilities at Billings, Mont.

. . . **Esso Standard Oil Co.'s** 10,000 b/d Fluid coker, the second ever built, has gone onstream at Baltimore. The first Fluid coker, Carter Oil's 3,800 b/d unit at Billings, Mont., has been on intermittent operation this summer.

. . . **These contracts have been awarded recently: Bankline Oil Co.** to Fluor Corp. for engineering and construction of a 4,000 b/d Fluid Coking unit at Bakersfield, Calif. Starting date: early 1956; **Texas Gulf Producing Co.** to Fish Engineering Co. for construction of an addition to Fish's natural gas plant at Headlee field, Texas; **Standard Oil Co. (Ind.)** to Ralph M. Parsons Co. for construction of $10,000,000, 14,000 b/d Ultraformer at Whiting refinery.

. . . **Phillips Petroleum Co.** has planned a 20% capacity increase for its lube oil plant at Kansas City, Kan.

. . . **General Petroleum Corp.** is planning to spend $3,600,000 next year on refinery expansion. First project will be another Platformer. Work is nearing completion on an earlier, $1,400,000, phase of program at General's Ferndale, Wash. refinery.

in Petrochemicals

. . . **DuPont** has completed plans for a multi-million dollar addition to the tetraethyl lead and Freon plant which is still going up near Antioch, Calif. The new section will manufacture sodium, ethyl chloride, trichlorethylene, and perchlorethylene. It is scheduled for completion by DuPont's Engineering Dept. in early 1957.

. . . **Cabot Carbon Co.,** Sarnia, Canada, will increase its oil furnace black capacity from 20,000,000 to 55,000,000 lb/yr.

. . . **Stauffer Chemical Co.** has structural and process engineering in progress for a $2,000,000 to $5,000,000 plant adjacent to its present facilities at Louisville, Kty. When completed in 1957 the plant will produce carbon tetrachloride, chloroform, methylene chloride, and anhydrous hydrogen chloride. For news of Stauffer's merger see Transition.

. . . **Standard Oil (N. J.)** is rumored to have picked its Bayway refinery as the site of an ethylene unit to supply the eastern market.

Expansion is still booming in Texas:

. . . **Carbon and Carbide Chemicals Co.** will build a $4,500,000 ethanolamines plant at Seadrift which will double the company's capacity for that product when completed in 1956.

. . . **J. M. Huber** will erect a 20,000,000 to 30,000,000 lb/yr furnace black plant at Borger, adding 15% to Huber's furnace black capacity.

. . . **Monsanto Chemical Co.** has plans for a multi-million dollar expansion of the ethylene facilities at its Plastics Division plant at Texas City. The 150% increase in ethylene production is tagged for internal use.

. . . **Petro-Tex Chemical Corp.** has awarded a contract to Bechtel Corp. for expanding butadiene facilities at Houston by about 50%, from current capacity of 90,000 t/yr to approximately 135,000. Completion is expected by end of 1956. Additional capacity will be obtained by using butane as a raw material.

. . . **Phillips Chemical Co.** has a contract to Farnsworth and Chambers Co. of Houston for the major construction work on Phillips' 110,000,000 lb/yr polyethylene products plant on the Houston Ship Channel. Cost will be about $7,500,000.

in Foreign Operations

. . . **Neste Oy,** a Finnish state-owned oil company has signed contracts for construction of a new refinery. 60% of the facilities and equipment will be provided by the French firm Cie de Vies-Lille, and 40% by the German Firm Mannesmann Rohrbau. Capacity of the Lummus affiliate designed plant will be 14,000 to 15,000 b/d. Neste Oy has been licensed to use Socony Mobil's cracking process, Atlantic Refining's Catforming process, and California Research's polymerization process. Interesting question is: How much of crude involved will come from east?

. . . **Jordan government** is planning to build a 4,000 b/d refinery near Zerka. Estimated cost: $45,600,000. The refinery is slated to handle the crude being paid Jordan as royalties for the pipeline crossing its territory. Capacity is 40% greater than current needs.

. . . **Richmond Exploration Co.,** a Standard of Calif. subsidiary, has plans for a $4,000,000 asphalt refinery at Maracaibo, Venezuela. Principal unit in the 10,000 b/d refinery will be a two stage distillation tower operating on 10.5° API Boscan crude.

. . . **Arthur Bernardes** refinery at Cubitão, Brazil is upping its production by 35%, and several new refineries are planned in a move to give Brazil independence in refined products.

. . . **Antar-Petroles de l'Atlantique** will add an 11,000 b/d catalytic reforming unit to its refinery at Donges. Its output of high octane gasoline, and petrochemical supplies will make the new plant one of the most important in Europe. Capacity of the French company's new asphalt unit is 22,000 t/yr.

. . . **Compagnie Financiere Belge des Petroles** has acquired a 75% interest in the Muelheim refinery of Ruhrbau G.H. Farbenfabriken Bayer Leverkusen, which originally owned a 50% interest in the now idle 2,100 b/d plant, will retain 25%.

. . . **Rheinishe Olefinwerke** has opened its $16,500,000 petrochemical plant in Wesseling, West Germany. Production schedule calls for 10,000 t/yr of polyethylene, and up to 12,000 t/yr of ethyl benzene.

. . . **Rohm & Haas, GmbH, Chemische Fabrik** has just brought new units onstream at Darmstadt producing acetone cyanhydrin from natural gas. Future production will expand to include methacryl acid ester, and possibly other petrochemicals.

. . . **Royal Dutch Shell** will build a $7,000,000 synthetic glycerin plant at its Pernis, Netherlands, refinery. The plant is expected to go onstream in 1957.

. . . **Shell Development Co.** will build a plant in the Netherlands for making epichloriyhdrin from refinery gases.

. . . **A new petro-chemical combine** in Roumania is producing ethylene from natural gas. Output is marked for plastics and synthetics.

. . . **Monsanto Chemicals Co. Ltd.** will build a new phthalic anhydride plant at Newport, England. The plant, which will cost an estimated $1,000,000 will boost Monsanto's production of phthalic anhydride in Great Britain to 15,000 t/yr.

in Transition

. . . **Stauffer Chemical Co. and Consolidated Chemical Industries** have reached agreement in principle on merging. Proposed name of the merged company would be Consolidated Chemical Industries Division of Stauffer Chemical Co.

. . . **Reichhold Chemicals and Catalin Corp.,** will be merged into Catalin and be called Reichhold Catalin Chemicals, Inc.

. . . **Standard Oil of Calif.** has offered $2,425,000 for the refining facilities of Pacific Refiners, Ltd., of Hawaii. The proposal will be submitted to stockholders. Standard has not indicated what effect this move would have on its plans for the $30,000,000 "no smog, no pollution, no odors" refinery designed for Honolulu. For details on this refinery see pp 1726-1728 in this issue.

. . . **W. M. Barnes Co.** is proposing to take over and operate the $1,000,000 wax refinery built for Sure Seal Corp. at North Lake, Utah. Barnes would spend $500,000 on rehabilitation and rearranging.

. . . **El Paso Natural Gas Co.** has purchased McNutt Oil & Refining Co. in a move toward diversification and full integration. Big plum for El Paso is McNutt's 4,000 b/d refinery at Brickland, N. M., and 125 retail outlets for petroleum products in the Southwest.

in Markets and Prices

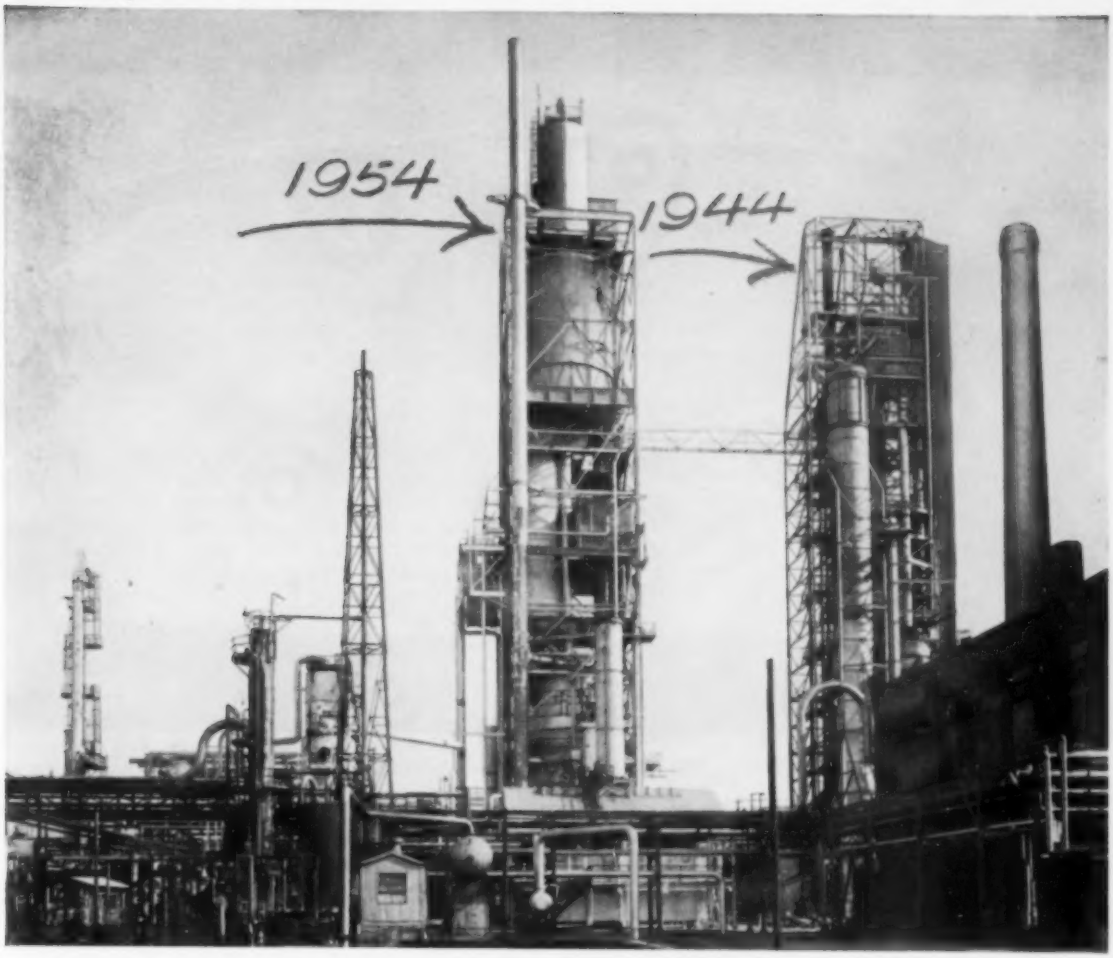
. . . **Outstanding strength of gasoline** highlighted oil markets in the early Fall period. The heating season got off to a slow start—distillate fuels were easy, but residuals, less dependent upon the heating market remained generally firm to strong.

Cargo traders on the Gulf Coast declared that gasoline was seeing its firmest Fall season in years. There was no prompt product to be had, and no discounting of quoted prices. This in sharp contrast with a year ago when quoted prices were about 0.5¢ gal. lower and subject to substantial discounts.

Midwest and Mid-Continent markets were in much the same shape on gasoline—several refiners who had been short of gasoline all summer were still on the buying side of the market.

. . . **Warm weather** in the large consuming areas held back movement of distillate fuels from primary to secondary storage. Both suppliers and distributors were sitting on record inventories. Many primary suppliers kept in force their summer-fill discounts through October. It had been generally anticipated that these special incentives would be discontinued by Oct. 1.

. . . **Heavy fuels were unsettled** along the Atlantic Coast, but price cuts there were confined to Philadelphia. At the Gulf and in the Mid-Continent, there was no easing in the tight residual situation which has been so marked since last spring.



NEW T.C.C. UNIT JOINS 10 YEAR OLD SISTER AT EAST ST. LOUIS REFINERY

Two Thermofor Catalytic Cracking Units stand here side by side at Socony Mobil Oil Company's East St. Louis refinery, where for 10 years one stood alone. Both were engineered and constructed by The Lummus Company.

The first unit, with 10,000 B/D total charge and bucket lift for catalyst, went on stream in 1944 and has operated satisfactorily ever since.

The second unit, complete with feed preparation, fractionation, and gas recovery sections and using gas lift for catalyst circulation, went on stream in November 1954. Its total charge is 15,000 B/D.

We feel that the confidence which Socony showed in choosing Lummus for the repeat unit, and the installation of other East St. Louis facilities at the same time, was justified by our performance on the job.

Working closely with Socony engineers at the refinery and in their main office in New York, Lummus performed all work with a minimum of interruption to normal refinery operations — thus maintaining maximum possible refinery production.

The construction proceeded smoothly without interruption, and start-ups of the separate units were in line with a pre-established schedule, dovetailing them with periodic refinery maintenance shutdowns.

Perhaps this suggests some ways in which Lummus might serve you when you consider new or expanded facilities.

The Lummus Company, 385 Madison Avenue, New York 17, New York. *Engineering and Sales Offices:* New York, Houston, Montreal, London, Paris, The Hague, Bombay. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricated Piping Plant:* East Chicago, Ind.

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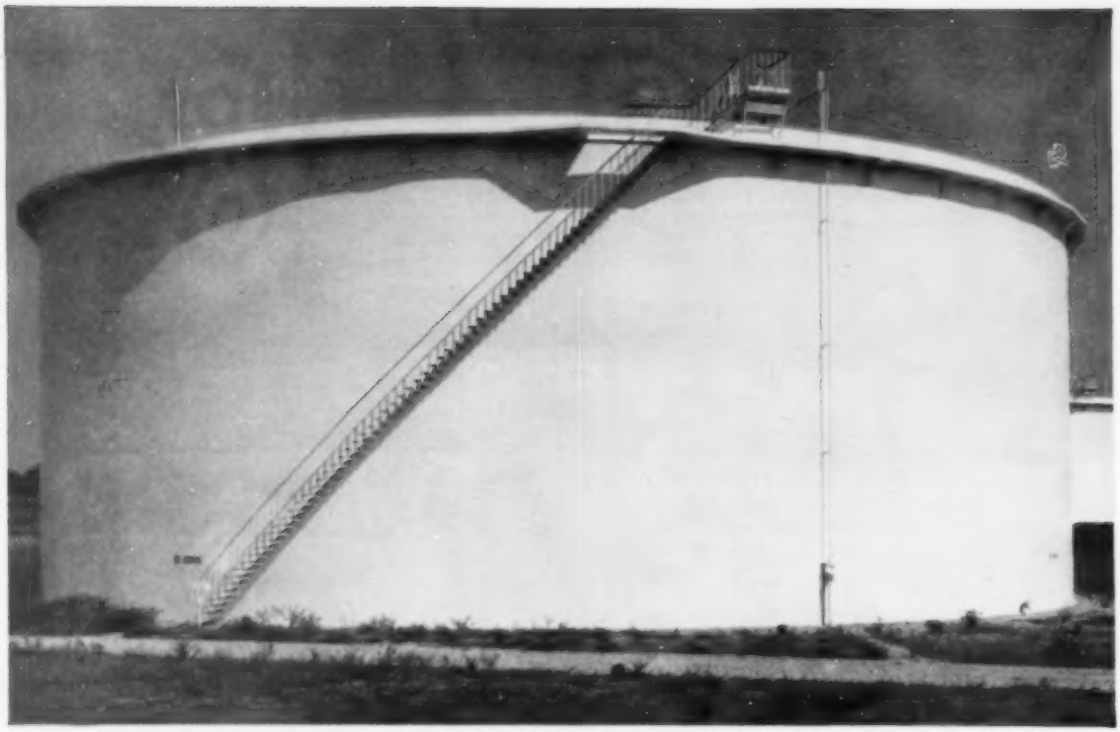

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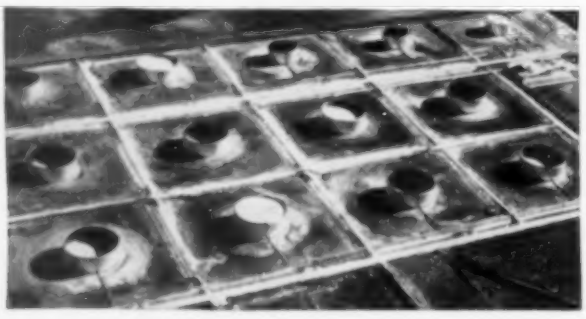
While the Graver Double-Deck Floating Roof Tank is the costliest of our three "floaters," it often proves least expensive in the long run.

Its unusual strength and structural stability make it appropriate wherever storage problems are encountered. The double-deck roof, consisting of top and bottom deck plate, is divided into liquid-tight compartments. Thus it is practically unsinkable. With the Graver Double-Deck Floating Roof Tank maintenance costs are held to a minimum.

Other popular Graver designs include the Center-Weighted Floating Roof Tank which is unusually stable. We offer also a pan-type floating roof...an economical design suitable to southern climates where snow and ice present no hazard.

Whatever your storage needs it will pay you to contact Graver. Consultation costs you nothing, and competent Conservation Engineers are ready to serve you.

GRAVER ...a conservation design to fit every need



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Petroleum Promises Still to Be Energy's Workhorse in 1975

BY a coincidence, the heads of three large oil companies recently presented separately their ideas on what the next two decades hold in store for the oil industry. Since each of these companies has a well-staffed economics department, these forecasts should be as sound as could be gathered from any source at this time.

It is significant that the estimates of the three executives as to petroleum demand in 1975 were in reasonably close agreement; also their estimates as to the population in this country 20 years hence.

In a statement placed in the cornerstone of the new Fundamental Investors, Inc., building in Elizabeth, N.J., in August, M. J. Rathbone, president of Standard Oil Co. (N.J.), said that petroleum demand in the U.S. in 1975 would be over 13 million b/d.(1) Our population at that time will be about 213 million, he estimates.

Another statement for the same occasion by T. S. Petersen, president of Standard Oil Co. of California, placed petroleum requirements at over 12 million b/d.(1) He said our population will be over 200 million and may possibly be as much as 225 million.

A third estimate was made by Albert L. Nickerson, president of Socony Mobil Oil Co., speaking before the Texas Mid-Continent Oil and Gas Association in Dallas, Texas, October 4. Mr. Nickerson estimated demand in 1975 at 12.5 million b/d.(2)

Biggest technological advance in energy, all three oil executives believe, will be the development of the use of atomic power. But, they do think that—two decades hence—the role of atomic energy will still be minor in the overall energy picture. "The energy workhorse still promises to be petroleum," stated Mr. Rathbone.

Referring to recent developments in the application of nuclear power in the energy-creating and other industrial fields, Mr. Nickerson said: "What this all adds up to is probably a gradual shift from conventional fuels to nuclear fuels as new electric power stations are built and as nuclear power becomes increasingly competitive with other fuels.

"There doesn't seem to be much likelihood that present power stations in the foreseeable future will convert to nuclear fuels. So, to the petroleum industry this will mean initially that the demand for its least valuable product— residual fuel oil—may not rise as rapidly as otherwise."

Next on the atomic power timetable, Mr. Nickerson believes, may be the use of nuclear fuels to propel ships and provide central heat and energy sources for some industrial operations. This suggests to him that the petroleum industry may eventually lose some of its potential market for diesel fuels as well as for heavy fuel oils.

Also, he said, we cannot disregard the possibility that, sometime between 1965 and 1975, electricity from nuclear energy may become economical in some areas as a central source of heat for homes and power for railroads.

The best yardstick of projected progress is past performance. To most of us, 1935 doesn't seem so very long ago. However, it is just as far in the past as 1975 lies in the future. Twenty years ago, consumption of petroleum was around 3.1 million b/d. Today, it is over 2½ times as much.

The estimated 1975 requirements—around 12.5 million b/d—is only about 45% larger than the present demand. The population increase from 165 to 210 million would be about 27%. In spite of the competition of other forms of energy fuels, the per capita consumption of petroleum will continue to gain, but at a much slower rate than in the past two decades.

As to the future competition of atomic energy with petroleum, Mr. Nickerson sounded an optimistic note:

"If nuclear energy does become an economic reality, the possibility exists of its bringing a great advance in our standard of living. The corresponding expansion in man's use of energy, especially in areas at present remote from deposits of coal or oil, might well provide new uses for petroleum that will tend to offset the uses that might be lost to the atom."

—V.B.G.

(1) Statements placed in the cornerstone of the Fundamental Investors, Inc., building, Elizabeth, N. J., August, 1955.
(2) "Future World Demand for Oil," Albert L. Nickerson, Socony Mobil Oil Co., Inc., at the Texas Mid-Continent Oil & Gas Ass'n. meeting, Dallas, Texas, October 4, 1955.

$64 Question — a Better Market For Butane-free Natural Gasoline

NATURAL gasoline manufacturers continue to face a disposal problem with butane-free natural gasoline, the relatively low octane value of which detracts from its usefulness as a motor gasoline component. Only a small proportion is susceptible to upgrading via catalytic reforming, because the usual end-point is below 300 ° F. and at least 90% must be evaporated at 275 ° F.(1) Stocks boiling below 200 ° F. are helped little by reforming.

Refiners face a similar problem in utilizing that portion of their straight-run gasoline coming from atmospheric distillation which boils below 200 ° F. and they are directing research efforts to find some means for up-grading these lower boiling, low octane fractions. Success in their investigations will help the natural gasoline producers as well as the refiners.

Another possibility for natural gasoline plants with excess butane-free natural has considerable potential advantages, but some disadvantages too. This is for a number of plants to arrange to pool their product, add some distillate gasoline if it's available, and jointly erect reforming and possibly isomerizing facilities to upgrade the product.

The individual company would find it difficult to justify installing its own reformer because of the

small volume of feedstocks from its own operation which could be helped by the reforming. Unfortunately, the drawbacks in the management aspects of such "community plants" often outweigh their advantages.

One possible bright spot in the outlook for butane-free natural gasoline is in the growing demand for jet fuels, specifications for which lie predominantly in the kerosine range, and in the development work by some refiners with motor gasolines of higher front-end volatility and lowered end-point.[2]

A refiner with large jet-fuel contracts, for instance, may find himself shy on catalytic cracking stock and hence in the market for butane-free natural. If he also makes a low end-point premium, he may have to blend more heavy material into the regular and—at the same time—divert more high octane components into the premium to make his gallonage. This, in turn, may make it worth his while to beef up his straight-run gasoline pool with the butane-free natural, even if he does have to upgrade some of it via reforming or some other methods.

Still further down the road is the possibility that automotive gas turbines, which are insensitive to octane number, may eventually displace conventional piston engines. As with jet aircraft engines, the lighter materials they use as fuels the greater their potential use of butane-free natural and similar components.

—D.P.T.

(1) Panel discussion, "The Future Market for Butane-Free Natural Gasoline," 34th annual convention, Natural Gasoline Ass'n. of America, Dallas, Texas, April 14, 1955.
(2) "What Next in Motor Fuels?" Petroleum Processing, Vol. 10, No. 3, pp. 343-346, March, 1955.

Low-Temperature Lignite Tar—Tomorrow's Source of Chemicals?

TAR from lignite might be one of tomorrow's important chemical raw materials. While in the past it was known that low-temperature lignite tar contained valuable chemical compounds, commercial quantities were not available for exploitation.

A new lignite tar plant built by the Aluminum Co. of America near Rockdale, Texas, is capable of producing 16,000 gal./day of tar. The prototype carbonizer and tar recovery unit is expected onstream soon.

Research and utilization of lignite tar became a possibility when Alcoa started its new aluminum smelter in Rockdale. Here dried lignite and carbonized lignite are used for the first time in this country as a fuel for power generation of aluminum smelting.

Research and utilization studies for the lignite tar are being conducted by Battelle Memorial Institute in Columbus, Ohio, in a program co-sponsored by Alcoa and Texas Power & Light Co., Dallas, Texas.

Research results will be furnished to companies now participating in the program, which include: Barrett Div. of Allied Chemical & Dye Corp., Carbide & Carbon Chemicals Co., Celanese Corp. of America, and Olin-Mathieson Chemical Corp., of New York City; Koppers Co., Inc., Pittsburgh, Pa.; The Merichem Co., and Oil and Chemical Products, Inc., of Houston, Texas; Reilly Tar & Chemical Corp., Indianapolis, Ind.; and Spencer Chemical Co., Kansas City, Mo.

Lignite tar products not purchased by these participating companies will be made available to other firms interested in the possibilities of this new raw material. Samples and specifications of materials now available can be obtained from Texas Power & Light Co. at Dallas, Texas.

—R. L. D.

One-Step Butane-to-Butadiene May Mean New Butane Outlets

NORMAL butane suppliers may find a new market for their product in the manufacture of butadiene or butylenes, now that synthetic rubber capacity as well as butadiene capacity is being increased by several producers.

Refinery butylenes were by far the most popular source material for butadiene manufacture when the World War II synthetic rubber program was being thrown into high gear as rapidly as possible. But that source is not as readily available now. Refiners need the butylenes for alkylate, their loss might severely crimp a given refiner's ability to produce high octane gasolines. Refiners who do not have alkylation units probably haven't the facilities to split out the butylenes; or wouldn't want to because this would interfere with catalytic polymerization operations.

Only one rubber plant in the country (Standard Oil Co. of Calif., El Segundo) was based on the one-step double dehydrogenation of n-butane to butadiene. Just recently a West German plant to produce 36,000 metric tons/yr. has been authorized (Chemische Werke Huels) while another in Texas apparently is over the financial hurdles (Texas Butadiene & Chemical Co.).

There is an interesting angle to the Houdry one-step process to be used in these plants which apparently hasn't been greatly appreciated in the past. It can make either butadiene or butylenes from the same charge stock using a high heat capacity, chromia-alumina catalyst. Designed only for butadiene, the El Segundo unit was converted after the war with a minimum of equipment changes to produce either material. Low pressure (6 in. Hg. abs.) favors butadiene; higher pressure (5 psig), butylenes.

The plant to be built in Texas was announced for 40,000 tons/yr. of butadiene and an undisclosed quantity of alkylate, although it was admitted that the balance between either product would be dictated primarily by market conditions. Refiners who are short of butylene for alkylation might also follow this same plan to augment their B-B supplies.

The other companies which have reported upcoming boosts in butadiene production may simply add to their existing systems—providing they can get all the butylenes they need, by purchase. Otherwise they, too, may look to butane for their additional starting material. One new entry via purchase into the butadiene manufacturing field indicated that all was not a bed of roses in the butylenes field by letting it be known that, if necessary, a gasoline plant would be built nearby to facilitate the supply of raw materials.

—D. P. T.

Letters

Using Engineers

To THE EDITOR: On page 649 of your May issue ("Do You Need More Engineers?") you have reported on a number of indoctrination programs conducted by the petroleum companies. I have been curious about the statement made that at a research laboratory where no refinery is readily available, indoctrination courses will normally last from three to six months.

We have been under the impression that most programs in research labs ran from two to four weeks. I am wondering if it would be possible to get any elaboration on your statement, such as what companies are involved; what type of people are included in the indoctrination programs; and the nature of these programs, whether lectures, discussions, visits to various locations, or rotational assignments.

W. N. RYERSON
Sun Oil Company
Research & Development Dept.
Marcus Hook, Penna.

• *The company where the indoctrination program is being carried on prefers to remain anonymous. However, they have been kind enough to reply to Mr. Ryerson, as follows:*

"The article states the indoctrination course at such locations lasts from three to six months. This does not mean that the entire period is devoted to indoctrination training, but rather that the lectures and discussions extend over this period as new employes become acquainted with operations and policies.

"The program, which is given only to new technical employes having a degree in engineering or science, may in some instances extend longer than six months after employment, but only the first two or three weeks are devoted exclusively to indoctrination and training. Following this, lectures and discussions are arranged at appropriate times and visits are scheduled to refining and terminaling facilities in the area."

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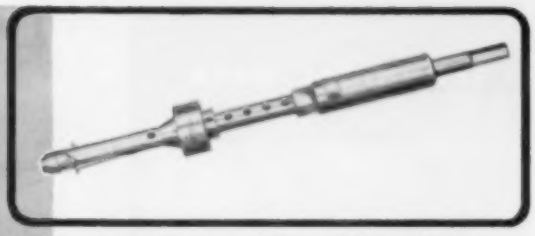
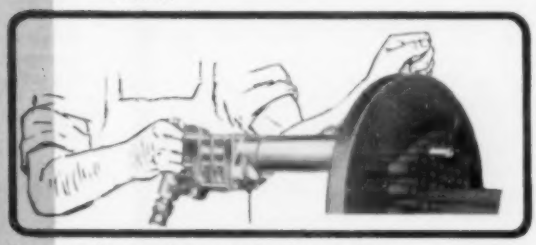


Now — a new push-type internal Tube Cutter

A time-saving maintenance tool that may be used with your present air or electric motor to cut non-ferrous tubes.

Easily carried. A must in every tool box.

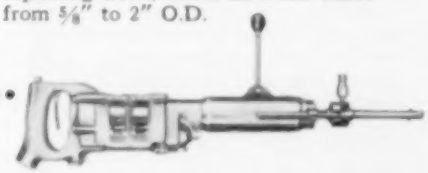
Many uses in every plant. Action of cutting blades is produced by pushing cutter into the tube which automatically opens the double cutter blades.



Works wonders when replacing tubes

Extremely useful. Saves time when replacing worn, small diameter tubes from ⅝" to 2" O.D.

Also furnished with motor and lever operator



An air-driven type internal tube cutter is available for production use. Cuts non-ferrous tubes 2–6 seconds each. Steel tubes 8–12 seconds each. Literature and complete details upon request.

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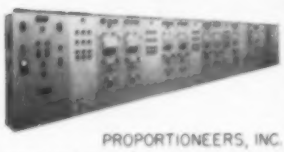
TECHNICAL DATA

Shell Products Pipe Line was one of the first to recognize the flexibility of operation made possible by continuous automatic "stream" blending. This company has installed B-I-F Industries' equipment at their Wood River Pump Station for blending finished gasolines directly to their North and East lines respectively. Preset formulations at all flow rates of finished product demanded by the pipeline are automatically maintained by multiple component blenders . . . to blend six gasoline base stocks, T.E.L., dye, and gasoline additives to pipe lines without intermediate tankage. Full particulars on this installation are available



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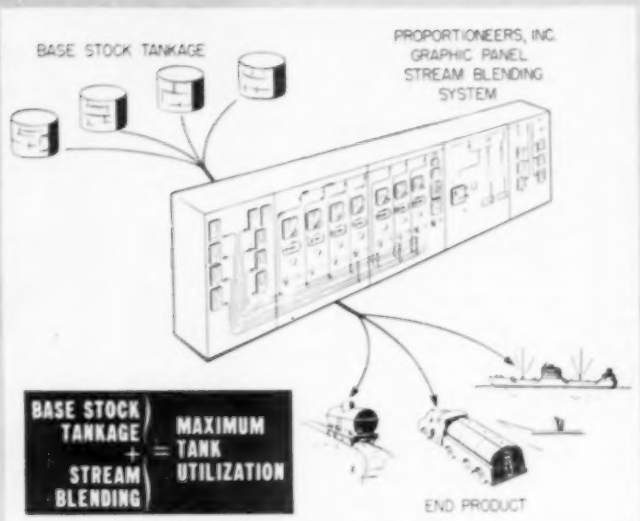
THE OCTANE EQUATION



THE PROBLEM

As automobile manufacturers continue their current trend toward higher-compression engines, refiners face an ever increasing demand for premium motor fuels. New processes, or improvements on existing processes, are being installed to meet these demands. The fuel outlook is further complicated by the fact that the automotive industry is developing engines requiring lower grade fuels . . . and predictions indicate these engines will be in use by 1960.

THE SOLUTION

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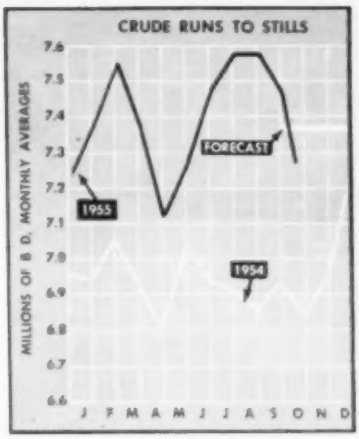
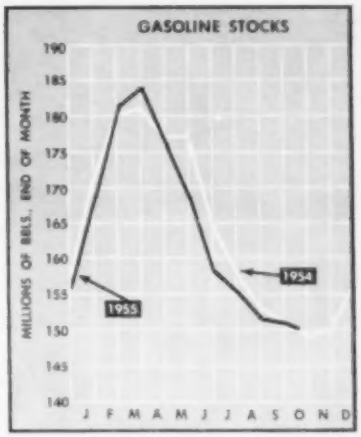
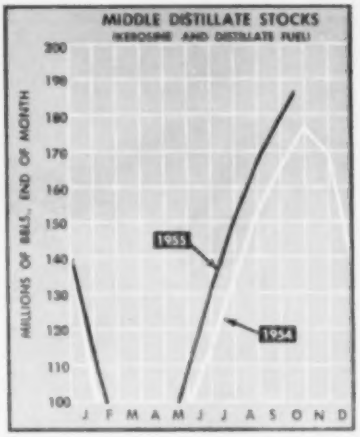






1955 figures to Oct. 14

Refiners Ready for Early Winter

DISTILLATE fuel oil stocks at refineries are about at their peak, although additions of a few million barrels may be expected before normal withdrawals start. While the U. S. total Oct. 14 was 15,596,000 bbls. higher than a year ago, except in a few districts, inventories are not far above what refiners need for protection against early cold weather.

Winter demand, with normal temperatures, is forecast at 9% larger than last year. Oct. 15 a year ago, U. S. distillate fuel oil inventories were 133,253,000 bbls., and the market was stable. Starting this season with 9% more in stocks to balance against that anticipated increase in demand, would bring total inventories to about 145,000,000 bbls. Actual inventories Oct. 14 were 148,849,000 bbls. East of California stock 9% higher than a year ago, would be nearly 130,500,000 bbls. Actual inventories Oct. 14 were 135,490,000 bbls.

OUTLOOK: Distillate fuel oil stocks won't drop below 120,000,000 bbls. by Dec. 31.

In the combined East and Gulf Coast districts, distillate fuel oil inventories Oct. 15, 1954, were 70,809,000 bbls. A projected 9% increase would bring them to around 77,200,000 bbls. Actual inventories Oct. 14 were 78,048,000 bbls.

In all inland refining districts, inventories 9% larger than in mid-October last year, would bring them to 53,387,000 bbls. Actual stocks there Oct. 14 were 57,442,000 bbls. In the Ind.-Ill.-Ky. district, stocks of last fall, projected 9%, would bring the figure to 28,110,000 bbls. Actual stocks Oct. 14 were 29,232,000 bbls.

A mild early heating season—and degree days thus far have been below normal needs—and continued high production at refineries, could put distillate fuel inventories a month hence, out of balance. For all of 1956, distillate fuel demand is forecast at only 6.2% greater than in 1955.

U. S. gasoline inventories Oct. 14 were 150,480,000 bbls. almost the same as Oct. 15, 1954. They represent 41 days' supply at the estimated rate of demand for coming weeks, compared with 45 days a year ago.

OCTOBER KEY STATISTICS

(Figures given in terms of millions of b/d, monthly averages, except stocks, which are in millions of bbls. at end of month)

	Oct. 1955*	Sept. 1955	Oct. 1954
CRUDE OIL			
U. S. Production	6.700	6.667	6.135
Imports	.759	.844	.642
U. S. Stocks	255.134	254.634	269.442
Runs to Stills	7.274	7.484	6.834
GASOLINE			
Refinery Output	3.708	3.683	3.362
Refinery Demand	3.859	3.864	3.515
Primary Stocks	150.480	151.266	149.661
MIDDLE DISTILLATES			
Refinery Output	1.821	1.905	1.855
Refinery Demand	1.397	1.469	1.513
Primary Stocks	186.077	180.135	176.268
RESIDUALS			
Refinery Output	1.097	1.088	1.066
Imports	.276	.284	.360
Total Supply	1.373	1.372	1.426
Refinery Demand	1.335	1.379	1.448
Primary Stocks	47.288	46.754	56.541

*Through Oct. 14

PRODUCT AND CRUDE PRICES

Products—¢ gal., weighted average prices in principal refinery markets
Crudes—$ bbl., principal fields
Source—Platt's Oilgram Price Service

	Oct. 1955*	Sept. 1955	Oct. 1954
Gasoline	11.81	11.78	11.20
Distillate Fuel Oil	8.85	8.90	8.87
Kerosine	10.33	10.40	10.37
Residuals	4.77	4.75	3.98
Above 4 Products	9.18	9.17	8.65
Lube Oils	18.67	18.04	16.24
Crude	2.83	2.82	2.81

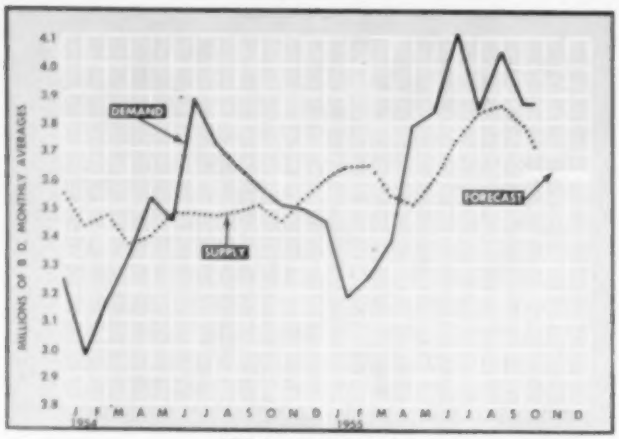
REFINERY YIELDS

% on Crude Runs to Stills	Oct. 1955*	Sept. 1955	Oct. 1954
Gasoline	46.2	44.6	43.8
Kerosine	4.1	3.9	4.5
Distillate	21.0	21.5	22.4
Residuals	15.1	14.5	15.4

*Through Oct. 14

SOURCE OF DATA (except prices): Aug., Sept. and Oct., API weekly reports; earlier months, Bureau of Mines

Strong Gasoline Demand Holds Into the Fall

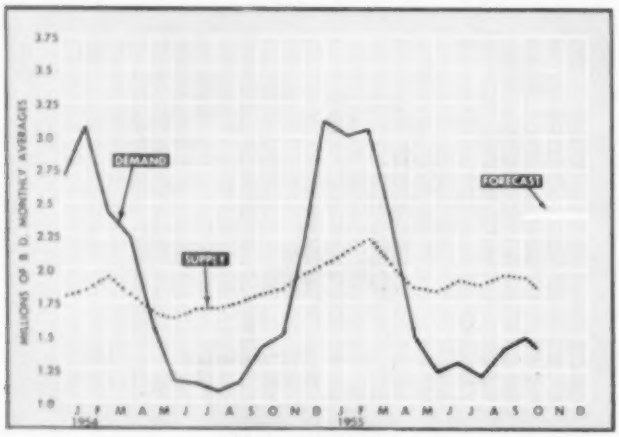


1955 figures to Oct. 14

MOTOR FUELS

	From Crude	From Nat. Gas	Total
SUPPLY (Millions of b/d)			
Sept. '55	3.336	.447	3.783
Sept. '54	3.071	.440	3.511
Change	+.265	+.007	+.272
% Change	+8.6	+1.6	+7.7
DEMAND (including Exports) (Millions of b/d)			
Sept. '55			3.864
Sept. '54			3.586
Change			+.278
% Change			+7.9
TOTAL SUPPLY (Millions of bbls.)			
9 Mos. '55	900.862	115.534	1,016.396
9 Mos. '54	830.718	113.618	944.336
Change	+70.144	+1.916	+72.060
% Change	+8.44	+1.7	+7.6
TOTAL DEMAND (including Exports) (Millions of bbls.)			
9 Mos. '55			1,012.375
9 Mos. '54			951.585
Change			+60.790
% Change			+6.4

Distillate Fuel Market Awaits Cold Weather

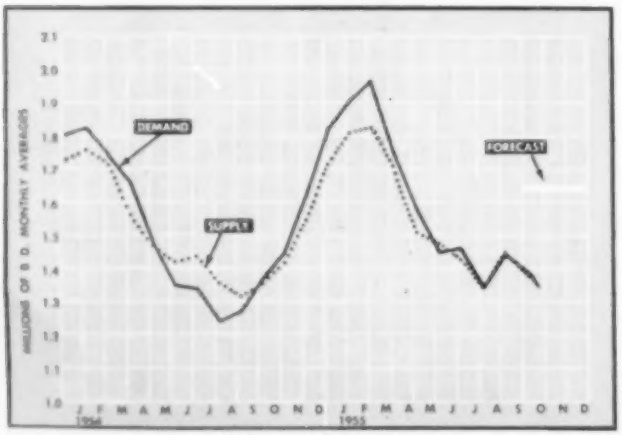


1955 figures to Oct. 14

MIDDLE DISTILLATES

	Kerosine	Dist. Fuel Oil	Total
PRODUCTION (Millions of b/d)			
Sept. '55	.294	1.611	1.905
Sept. '54	.301	1.514	1.815
Change	—.007	+.097	+.090
% Change	—2.3	+6.4	+5.0
DEMAND (Including Exports) (Millions of b/d)			
Sept. '55	.237	1.232	1.469
Sept. '54	.229	1.186	1.415
Change	+.008	+.046	+.054
% Change	+3.5	+3.9	+3.8
TOTAL PRODUCTION (Millions of bbls.)			
9 Mos. '55	87.738	447.347	535.085
9 Mos. '54	90.294	394.004	484.298
Change	—2.556	+53.343	+50.787
% Change	—2.8	+13.5	+10.5
TOTAL DEMAND (including Exports) (Millions of bbls.)			
9 Mos. '55	78.535	412.569	491.104
9 Mos. '54	81.879	382.604	464.483
Change	—3.344	+29.965	+26.621
% Change	—4.1	+7.8	+5.7

Fall Residual Fuel Demand is Lagging



1955 figures to Oct. 14

RESIDUAL FUELS

	Refinery Output	Imports	Total
SUPPLY (Millions of b/d)			
Sept. '55	1.088	.284	1.372
Sept. '54	1.086	.279	1.365
Change	+.002	+.005	+.007
% Change	+0.1	+1.8	+0.5
DEMAND (Including Exports) (Millions of b/d)			
Sept. '55			1.379
Sept. '54			1.368
Change			+.011
% Change			+0.8
TOTAL SUPPLY (Millions of bbls.)			
9 Mos. '55	310.521	108.584	419.105
9 Mos. '54	313.311	93.238	406.549
Change	—2.790	+15.346	+12.556
% Change	—0.9	+16.5	+3.1
TOTAL DEMAND (Including Exports) (Millions of bbls.)			
9 Mos. '55			428.466
9 Mos. '54			403.646
Change			+24.820
% Change			+6.1

SOURCE OF DATA: Aug., Sept. and Oct., API weekly reports; earlier months, Bureau of Mines

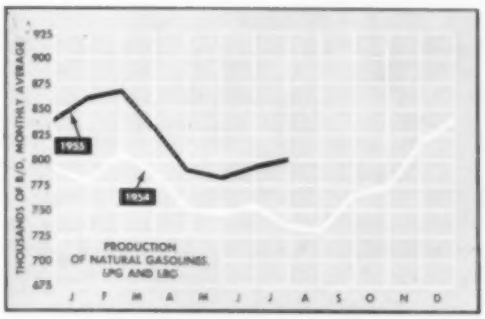
RUNS TO STILLS AND DISTRIBUTION OF PRIMARY STOCKS BY U.S. REFINERY DISTRICTS

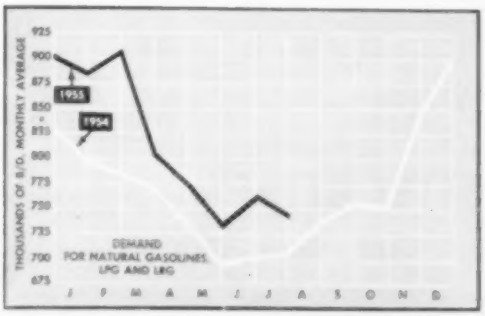
(Primary stocks include those at refineries, at large terminals and in pipelines; all data based on API reports)

District	RUNS TO STILLS (Millions of b/d average for week ending on date shown) Oct. 14 1955	Oct. 15 1954	Change	% Change	GASOLINE STOCKS (Millions of bbls., on date shown) Oct. 14 1955	Oct. 15 1954	Change	% Change	RESIDUAL STOCKS (Millions of bbls., on date shown) Oct. 14 1955	Oct. 15 1954	Change	% Change
East Coast	.991	1.014	— .023	— 2.3	35.159	34.639	+ .520	+ 1.5	14.021	10.630	+ 3.391	+31.9
Gulf Coast	2.499	2.244	+ .255	+11.4	28.266	29.374	— 1.108	— 3.8	8.402	7.446	+ .956	+12.8
Total Coastal	3.490	3.258	+ .232	+ 7.1	63.425	64.013	— .588	— 0.9	22.423	18.076	+ 4.347	+24.0
Appalachian	.206	.171	+ .035	+20.5	6.443	6.627	— .184	— 2.8	.951	.831	+ .120	+14.4
Ind.-Ill.-Ky.	1.309	1.184	+ .125	+10.6	30.675	33.081	— 2.406	— 7.3	5.045	4.402	+ .643	+14.6
Okla.-Kans.-Mo.	.656	.596	+ .060	+10.1	14.597	13.480	+1.117	+ 8.3	1.590	1.298	+ .292	+22.5
Other Inland	.590	.545	+ .045	+ 8.3	14.556	15.235	— .679	— 4.5	2.338	2.222	+ .116	+ 5.2
Total Inland	2.761	2.496	+ .265	+10.6	66.271	68.423	— 2.152	— 3.1	9.924	8.753	+ 1.171	+13.4
Total East of Calif.	6.251	5.754	+ .497	+ 8.6	129.696	132.436	— 2.740	— 2.1	32.347	26.829	+ 5.518	+20.6
California	1.106	1.011	+ .095	+ 9.4	20.784	18.240	+ 2.544	+13.9	14.941	29.355	— 14.414	—49.1
Total U. S.	7.357	6.765	+ .592	+ 8.8	150.480	150.676	— .196	— 0.1	47.288	56.184	— 8.896	—15.8

District	DISTILLATE FUEL OIL STOCKS (Millions of bbls., on date shown) Oct. 14 1955	Oct. 15 1954	Change	% Change	KEROSINE STOCKS (Millions of bbls., on date shown) Oct. 14 1955	Oct. 15 1954	Change	% Change	TOTAL MIDDLE DISTILLATE STOCK (Millions of bbls., on date shown) Oct. 14 1955	Oct. 15 1954	Change	% Change
East Coast	55.892	49.393	+ 6.499	+13.2	14.953	15.399	— .446	— 2.9	70.845	64.792	+ 6.053	+ 9.3
Gulf Coast	22.156	21.416	+ .740	+ 3.5	6.481	7.800	— 1.319	—16.9	28.637	29.216	— .579	— 2.0
Total Coastal	78.048	70.809	+ 7.239	+10.2	21.434	23.199	— 1.765	— 7.6	99.482	94.008	+ 5.474	+ 5.8
Appalachian	4.281	3.545	+ .736	+20.8	1.221	1.231	— .010	— 0.8	5.502	4.776	+ .726	+15.2
Ind.-Ill.-Ky.	29.232	25.786	+ 3.446	+13.4	9.448	9.989	— .541	— 5.4	38.680	35.775	+ 2.905	+ 8.1
Okla.-Kans.-Mo.	15.755	13.186	+ 2.569	+19.5	2.538	2.451	+ .087	+ 3.5	18.293	15.637	+ 2.656	+17.0
Other Inland	8.174	6.462	+ 1.712	+26.5	2.281	1.557	+ .724	+46.5	10.455	8.019	+ 2.436	+30.4
Total Inland	57.442	48.979	+ 8.463	+17.3	15.488	15.228	+ .260	+ 1.7	72.930	64.207	+ 8.723	+13.6
Total East of Calif.	135.490	119.788	+15.702	+13.1	36.922	38.427	— 1.505	— 3.9	172.412	158.215	+14.197	+ 9.0
California	13.359	13.465	— .106	— 0.8	.306	.369	— .063	—17.1	13.665	13.834	— .169	— 1.2
Total U. S.	148.849	133.253	+15.596	+11.7	37.228	38.796	— 1.568	— 4.0	186.077	172.049	+14.028	+ 8.2

Natural Gas and Refinery Gas Liquids





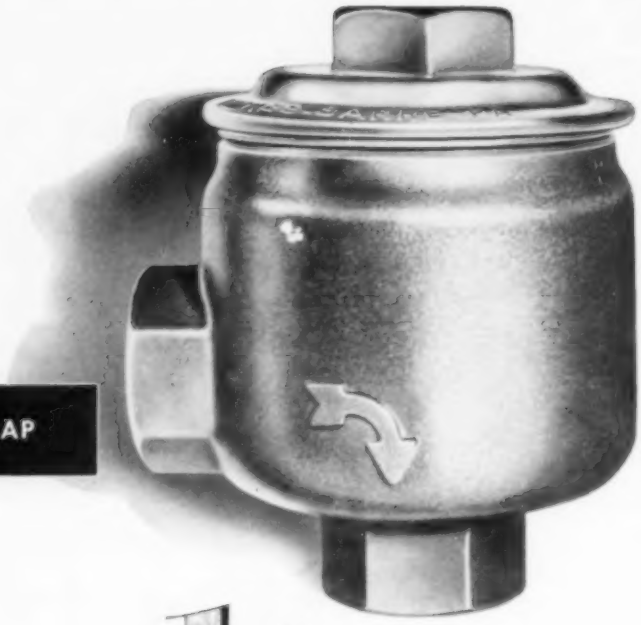
SUPPLY AND DEMAND STATISTICS

(Bureau of Mines Data)

CURRENT PRODUCTION (1000 b/d monthly average)	July 1955	June 1955	July 1954
At Natural Gasoline and Cycling Plants			
Liquefied Petroleum Gas	316	313	286
Natural Gasoline and Isopentane	283	278	273
Condensate	20	20	24
Finished Gasoline, Naphtha and other	60	61	59
Total Natural Gasoline and Cycling Plant Production	679	672	642
Liquefied Refinery Gases	123	123	92
Total Marketable Gas Liquids	802	795	734
Lease Condensate	103	103	100
Total Natural Gas Liquids	905	898	834
CURRENT DEMAND (1000 b/d monthly average)			
LPG and LRG	395	387	362
Natural Gasoline, Isopentane and Other	349	378	344
Total Marketable Gas Liquids	744	765	706

CUMULATIVE PRODUCTION (1000 bbls.)	July 1955	July 1954
LPG and LRG	97,606	87,958
Natural Gasoline, Isopentane and Other	75,879	74,171
Total Marketable Gas Liquids	173,485	162,129
CUMULATIVE DEMAND (1000 bbls.)		
LPG and LRG	93,886	83,311
Natural Gasoline, Isopentane and Other	75,868	73,754
Total Marketable Gas Liquids	169,754	157,065

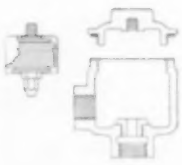
STOCKS (1000 bbls., end of month)	July 1955	June 1955	July 1954
LPG and LRG	11,478	10,105	9,123
Natural Gasoline, Isopentane and Other	4,669	4,242	5,306
Total Stocks	16,147	14,347	14,429



STEAM TRAP

Quality

Just 3 quality parts—thermostatic bellows, body, cap. Simple, positive action. Won't leak!



Nicholson quality . . . that gives you the extra strength, extra capacity, extra *stamina* required for severest petroleum processing service. Nicholson quality pays off, when it comes to discharging condensate and air from steam lines . . . most efficiently, dependably, economically.

- **Powerful valve action—big husky bellows.**
- **Positive shut-off—finely ground valve and seat.**
- **High capacity—large diameter orifice.**
- **Rigidly tested—on actual steam lines.**

When less than best won't do, specify Nicholson. Send for *Catalog 953*.

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DU PONT

PETROLEUM CHEMICALS DIVISION NEWS

DU PONT

November ★ One of a Series of Interest to the Petroleum Industry ★ 1955

NEW DU PONT TEL PLANT NOW UNDER CONSTRUCTION IN CALIFORNIA

On August 24, near Antioch, California, the ground was officially broken for construction of Du Pont's new West Coast tetraethyl lead manufacturing plant. Many local Antioch dignitaries were on hand for the ground breaking ceremony.

This California plant site has much to recommend its choice by Du Pont . . . including the local availability of necessary labor skills, its convenient location in the heart of a growing market for TEL, adequate supplies of power and good water, plus the option of water or rail shipments.

In addition to employing the most modern continuous process methods of manufacturing TEL, the new plant will include a unique new waste disposal system. The waste materials will be discharged into a deep underground well — in excess of 6,000 feet to eliminate any danger of contaminating surface water.

A new plant for manufacturing Du Pont "FREON" is also being built on the Antioch site.

Two lube oil additives to help you sell fleet contracts

For refiners interested in fleet contracts, Du Pont's two polymeric lube oil additives offer special sales advantages, especially with owners of fleets in low-duty, stop-and-start use.

Du Pont Lube Oil Additive 564 and Du Pont Lube Oil Additive 565 provide an economical and effective means of preventing engine oil sludge. They are particularly effective under low-temperature, low-power, stop-and-go driving conditions. Both work as detergents and V. I. improvers.

LOA-564, with its lower molecular weight gives an engine oil with excellent shear stability. The higher molecular weight of LOA-565 gives greater viscosity index improvement.

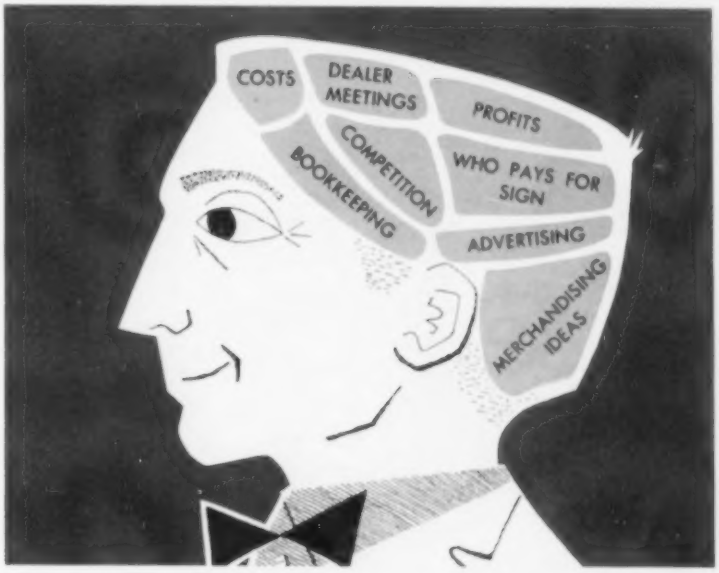
Both are ashless. They keep engine oil systems clean and free of sludge under severe conditions . . . contribute to longer engine life.

Besides providing extra sales appeal for fleet customers, the benefits of these additives offer exceptional promotion and marketing opportunities with the mass passenger car field. Information and samples are available through your Du Pont representative or sales office.

What Do Your Dealers Really Think...

Of your dealer meetings? . . . Your advertising? . . . Your dealer publications and sales promotion aids?

Report No. 3 of the new Du Pont survey—"The Service Station Operator"—is now off the press. If you want to get behind the scene at the pump island and study the effect of your promotion program on your dealers, you'll surely want to take an early peek at the results of this survey.



Increasing the merchandising savvy of the service station operator is probably the chief objective of all dealer training and promotion programs. But to achieve this, you first need the interest and cooperation of the dealers themselves.

The index of this interest and cooperation can be found, we believe, in the dealers' answers to questions asked them in this recent dealer survey.

Are they helpful?

The dealers were asked how many meetings their company invited them to each year . . . and how many of these they attended. Their answers, you'll find in the survey report, ranged all the way from none to a baker's dozen. But what was accomplished at these meetings is the most important thing.

You'll be glad to know that a large majority of them found the meetings *helpful*. How? Their answers ranged all the way from "sales tips" to "news of trade." And the survey report will also tell you what parts of the program are actually *put to work at the station* by the dealers.

What they want

Some dealers, the survey found, would like to have their supplier companies do *more* for them. And they listed several things specifically. Station modernization was one of the things most frequently mentioned. Many of them also indicated they would like to see revisions in the companies' advertising.

Telling is selling

How do the dealers feel about their supplier's policies on rental arrangements, advertising, competitive pric-

ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

OVER

DU PONT

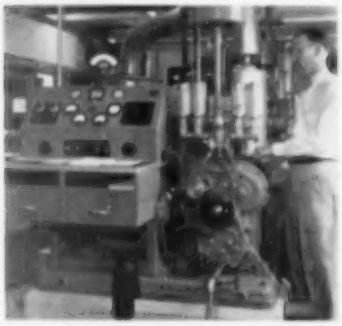
PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

New, Modern Regional Laboratory at Tulsa

A complete modernization program has just been completed at the Du Pont Mid-Continent regional laboratory in Tulsa, Oklahoma. The photographs below show how the air-conditioned lab building has been modernized and new equipment added. Improved customer service is the objective.

Over-all view of the new regional laboratory interior. You can also see from this picture that the regional lab people take considerable care with their housekeeping.



H. M. Carey operating the Tulsa lab's new CFR octane number test engine.

The new set-up at the laboratory for analyzing copper, antioxidant and metal deactivator content. This equipment is also used for color work. Blake Portain is shown in the foreground.

MID-CONTINENT REGIONAL LAB MANAGER

E. ODELL CAMPBELL joined the Du Pont Petroleum Chemicals Division in 1951. Since that time he has managed the Division's Mid-Continent regional laboratory in Tulsa, Oklahoma. He is in charge of Du Pont customer service, product testing, and additives treating recommendations in the region.

Following college, he did general petroleum testing, and later was made a Petroleum Chemist in charge of a phase of the research work at the Bureau of Mines Petroleum Experimental Station in Bartlesville.

During World War II he was a commissioned officer in the U. S. Navy. From 1945 to 1951 he served with the Munitions Board. There his job as a chemical engineer included petroleum planning and coordination of technical petroleum problems for the three military services.

Mr. Campbell received his B. A. degree in Chemistry at the University of Oklahoma, and later studied at the University of Arizona and George Washington University. He is a member of the American Chemical Society, Alpha Chi Sigma Fraternity, and the American Association for the Advancement of Science.

E. ODELL CAMPBELL

CONTINUED

Dealer Survey

ing, training programs, etc.? In general, when the dealers know and understand these policies, they like them. However, a large number of dealers, so the survey found, are not aware of their supplier's policies on these matters.

In addition to the above areas, this Report No. 3 delves into the dealer's opinions of dealer publications, overall company advertising and point-of-sale merchandising displays. Their opinions of supplier representatives are also documented. And the report includes information on the dealer's own advertising programs, too.

Complete series of reports

The previous two reports in the series cover (1) such dealer retail functions as station hours, gallonage, credit and mailing lists; and (2) dealer knowledge of products, additives, sales assets and prices. Future reports, to be published soon, will discuss (4) employee-dealer relationships, dealer associations, his educational background and income; and (5) the interrelationship of all the above factors . . . such as how station hours, dealer meetings and education affect sales volume.

Continuing market research

Sponsored by Du Pont, the survey was conducted on a completely impartial basis by National Analysts, Inc. It is nationwide in scope and part of the continuing market research work of the Du Pont Petroleum Chemicals Division. It follows the recent Du Pont survey of service station customer buying habits.

For more information about this survey, just get in touch with any of our representatives or sales offices listed below.

DU PONT

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ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)

Printed in U. S. A.

TWENTY-FOOT LENGTHS of 10" I.D. copper tubes receive final inspection in one of the mills of The American Brass Company. ANACONDA Seamless Drawn Copper Tubes are made up to 26" I.D.

Anaconda Copper Tubes install easier . . . last longer

Planning a new installation? Want to replace unsatisfactory piping? Then look into the performance advantages of ANACONDA Copper Tubes *first*. Many plants have found them the best all-around piping material available.

Here's why: ANACONDA Copper Tubes are light. They come in long lengths. Smaller sizes are bent right on the job. All this means big savings on installation costs. And copper tubes can't rust. They resist corrosion and guard against contamination. Smooth interiors mean smoother flow. Pumping costs are often lower.

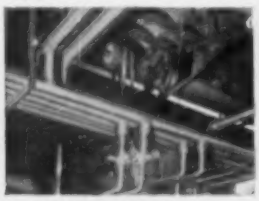
Here's another advantage. ANACONDA Copper Tubes – connected with solder-type fittings – can be taken down, moved or have new connections cut in faster than with threaded pipe. *You can meet changing plant conditions easily.*

If we can be of assistance in solving a piping problem in your plant please write to: *The American Brass Company, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ont.*

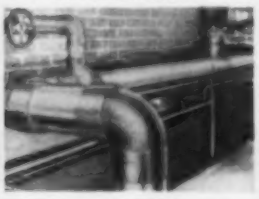
B-4008A

Use Anaconda Copper Tubes for:

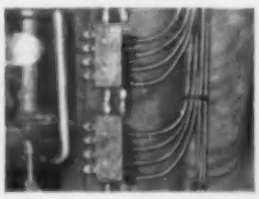
REFRIGERATION AND AIR CONDITIONING



HOT AND COLD WATER SUPPLY LINES



INDUSTRIAL HEATING LINES



AIR, LUBRICATING AND HYDRAULIC LINES

for copper piping call an

ANACONDA

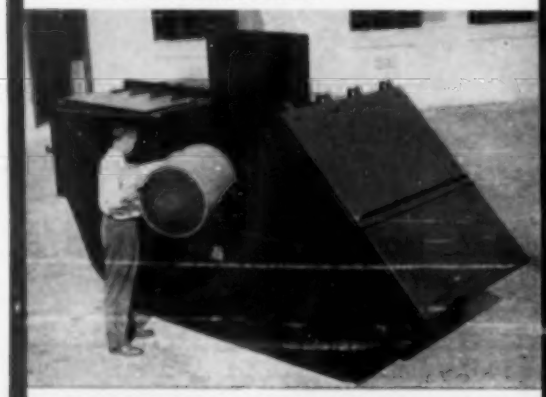
Distributor

COLLECT IT

AS IT ACCUMULATES — SOLIDS, POWDERS, SLUDGE, LIQUIDS
RAW MATERIALS, FINISHED PRODUCTS, WASTE MATERIALS

Heavy waste is dumped into an open container at a foundry in New York. The first step in the LOAD LUGGER SYSTEM of materials handling is to place a number of containers at strategic points to collect material as it accumulates, reducing handling at the point of origin.

Light material accumulates in an open container with high sides at a shipping carton plant in Louisiana. Rugged LOAD LUGGER containers are built of welded steel, have deep leak-proof bottoms, hold from 1½ to 14 cubic yards and more, and handle all types of material.



It is easy to load this 14-cubic-yard LOAD LUGGER container of a St. Louis contract hauler. It fills to the top without raking and is wind-proof and rat-proof. A model with rubber seals and latches is also theft-proof, fly-proof, dust-proof, and almost odor-proof.

PICK IT UP

ALREADY LOADED — NO LOST TIME AND NO LOADING CREWS
LET ONE TRUCK AND DRIVER DO IT ALL — REPLACING MANY

A full container is picked up at a refinery in Indiana. The second step in the LOAD LUGGER SYSTEM is for one driver and his truck equipped with a hoist-body to pick up full containers on a regular schedule. This procedure does away with lost time and loading crews and eliminates the need for several conventional trucks and their drivers.

A bearing manufacturer in Ohio picks up a full container of dolomite. LOAD LUGGER hoist-bodies (flat-bed truck bodies with a pair of hydraulic-powered hoisting arms) handle pay loads of up to 18,000 pounds and more. They are easily mounted on any truck chassis of suitable capacity, and all controls are installed in the cab.

An open container used for accumulating industrial wastes is picked up by a Chicago contract hauler. For greater safety, LOAD LUGGER hoist-bodies lift containers with four-point suspension and have double-acting hydraulic cylinders for positive control at all times.

LOAD LUGGER®

ENGINEERING B-W PRODUCTION

• FLAT-BED TRUCK BODIES WITH HYDRAULIC HOISTING ARMS
• LEAK-PROOF TILT-DUMP CONTAINERS FOR BULK MATERIALS

HAUL IT

IN MANY TYPES OF CONTAINERS — OR ON THE TRUCK BED IN PLANT AND OVER THE ROAD — ON YOUR TRUCK CHASSIS

A city truck in Ohio hauls a full container of repair materials. Government approval is evidenced by the many such municipal, state, and federal installations. Hauling full containers is the third step in the LOAD LUGGER SYSTEM, and over-the-road hauls are as feasible as in-plant because of the use of standard truck chassis.

A full container of residue materials is hauled at a corn products processing plant in Illinois. LOAD LUGGER hoist-bodies carry containers well forward for correct load distribution and cradle them between steel sidewalls for greater travel safety.

LOAD LUGGER hoist-bodies also carry materials or equipment directly on their flat beds, loading and unloading heavy objects with their hoisting arms.

This special hoist-body of a Michigan telephone company transports heavy cable reels. Such new uses for LOAD LUGGER equipment are constantly being developed.

DUMP IT

BY TILTING CONTAINER VERTICALLY OVER REAR APRON, OR DELIVER IT BY EXCHANGING FULL CONTAINER FOR AN EMPTY

Spent solvents are dumped into incinerator tank at a drugs and medicines manufacturing plant in Michigan. Delivering full containers or dumping their loads is the fourth step in the LOAD LUGGER SYSTEM. Returning empty containers then completes the cycle.

Metal scrap is dumped and spread in the yards of a scrap metals service company in Iowa. LOAD LUGGER hoist-bodies handle more pay load on a given truck chassis, because they are lighter than comparable equipment. And their patented simplicity, clean design, and sturdy construction make them cost less to buy and maintain.

Equipment of a Miami contract hauler in the dumping position. The LOAD LUGGER hoist-body has outrigger jacks to protect rear springs and axles from injury while picking up and putting down heavily loaded containers, but it neither needs nor uses these jacks while tilting container over rear apron to dump or spread the load.

ENGINEERED, MANUFACTURED, AND MARKETED BY

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BORG-WARNER CORPORATION

EXPORT SALES: BORG-WARNER INTERNATIONAL CORP., CHICAGO

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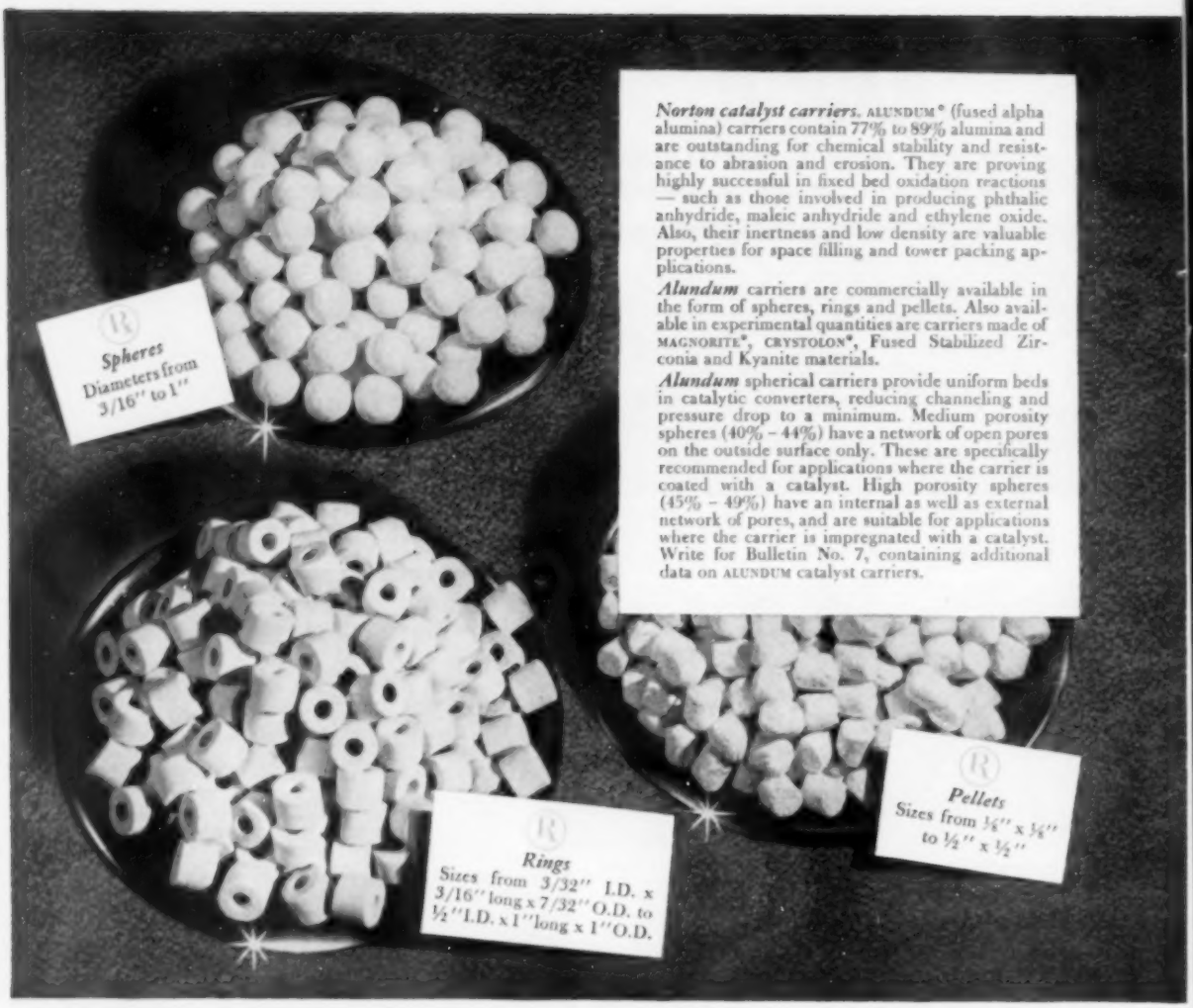


Norton catalyst carriers. ALUNDUM® (fused alpha alumina) carriers contain 77% to 89% alumina and are outstanding for chemical stability and resistance to abrasion and erosion. They are proving highly successful in fixed bed oxidation reactions — such as those involved in producing phthalic anhydride, maleic anhydride and ethylene oxide. Also, their inertness and low density are valuable properties for space filling and tower packing applications.

Alundum carriers are commercially available in the form of spheres, rings and pellets. Also available in experimental quantities are carriers made of MAGNORITE®, CRYSTOLON®, Fused Stabilized Zirconia and Kyanite materials.

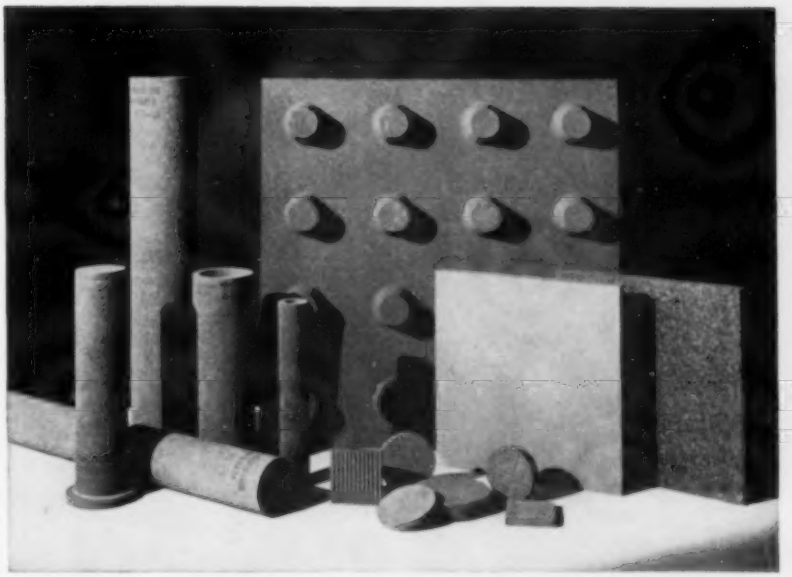
Alundum spherical carriers provide uniform beds in catalytic converters, reducing channeling and pressure drop to a minimum. Medium porosity spheres (40% – 44%) have a network of open pores on the outside surface only. These are specifically recommended for applications where the carrier is coated with a catalyst. High porosity spheres (45% – 49%) have an internal as well as external network of pores, and are suitable for applications where the carrier is impregnated with a catalyst. Write for Bulletin No. 7, containing additional data on ALUNDUM catalyst carriers.

Rx for more profitable processing

Norton engineered and prescribed refractories are proved aids to better, lower cost production

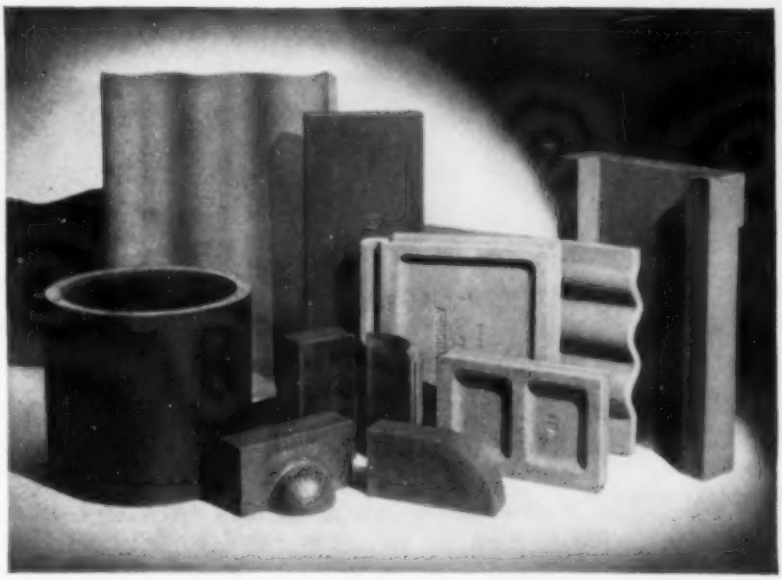
Backed by over 50 years of experience in electrochemical refining, Norton produces refractories whose purity and properties are carefully controlled and consistently duplicated. These refractories are *engineered and prescribed* to give you the best possible Rx — the most effective combination of physical characteristics, plus thermal, chemical and electrical properties — for your particular applications.

Chemical engineers are finding these Rx's of immense practical value in widely varying processes. Whatever your own processes may be, it will pay you to learn more about the many advantages of Norton refractories. Just a few products in this complete, top-quality line are described here. For complete details, and expert technical aid, call in your Norton Refractories Engineer. Meanwhile, write direct for the illustrated bulletins, mentioned in this advertisement, that cover your requirements. NORTON COMPANY, 270 New Bond Street, Worcester 6, Mass. *Canadian Representative:* A. P. Green Fire Brick Co., Ltd., Toronto, Can.



Norton porous mediums come in plates, tubes, discs and diaphragms, engineered to fit your filtering, diffusing or aerating requirements. All have uniform porosity, in the size and open-pore ratio you need. Made of ALUNDUM material that is chemically stable and strong, their resistance both to acid and alkaline conditions gives them extra long life. Norton seamless porous tubes have the advantage, unusual in tubes, of uniform porosity over their entire area — permitting constant air or liquid pressure and enabling uniform backwashing to do more thorough cleaning.

Typical applications are filtering water or solvents; cutting oils, wine and other liquids; reclaiming cleaning fluids; handling industrial oil wastes; chlorination, carbonation and other gas diffusion applications. Bulletin No. 140 tells you more about Norton ALUNDUM porous mediums.



Norton refractory shapes for reaction furnaces come in bricks, plates, tubes and blocks, made of ALUNDUM, CRYSTOLON, MAGNORITE and Fused Stabilized Zirconia refractory materials. The development of Fused Stabilized Zirconia is a typical example of how Norton aids you in utilizing higher temperatures for greater efficiency and output. Norton was the first to bring this valuable material out of the experimental stage into commercial production. Now it is used in many processes.

No other refractory is so chemically stable at such high temperatures under both oxidizing and reducing conditions. In gas synthetic processes, furnaces lined with it have withstood temperatures approaching 4700°F for long periods. Its low thermal conductivity (6.2 BTU in dense shapes at 2000°F) and its high electrical conductivity at high heat are other important properties, all of which are described in Bulletin No. 1741.

Norton electric furnace shapes and laboratory ware

Norton electric furnace refractories — cores, tubes and muffles — are made of ALUNDUM or CRYSTOLON materials. ALUNDUM shapes, composed of 99% pure fused alumina, are characterized by great stability, chemical inertness, excellent thermal conductivity and good electrical insulation qualities. CRYSTOLON shapes, for use under more limited conditions, combine high thermal conductivity with resistance to heat shock. Bulletin No. 458 tells how to construct electrical furnaces for the laboratory.

Norton ALUNDUM laboratory ware, available at your laboratory supply house, offers many properties important to development, experimental or analytical work. It is chemically stable, stands temperatures up to 1900°C and is easy to clean. For filtering, it comes in four degrees of permeability. Bulletin No. 793 gives you the whole story.

NORTON

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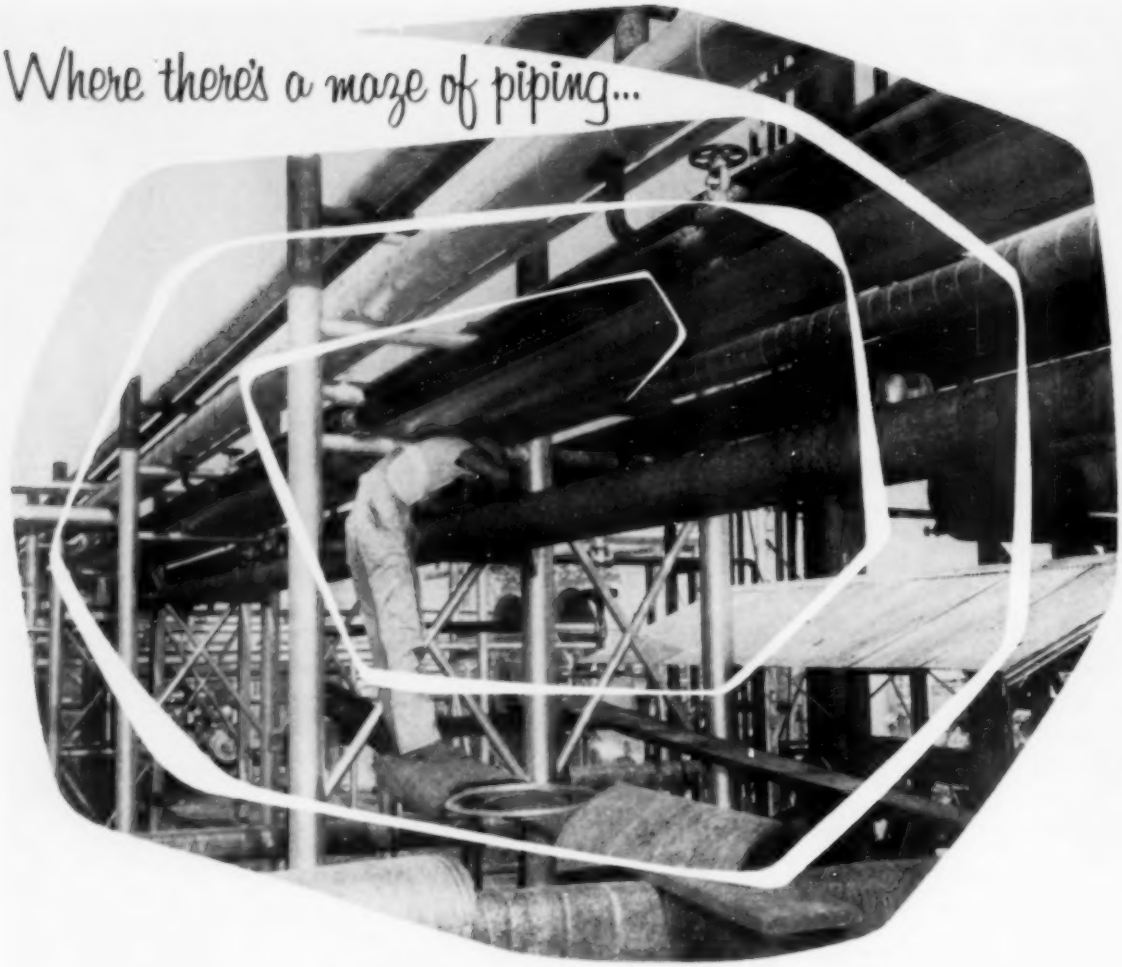
Engineered . . . Rx . . . Prescribed

Making better products . . . to make your products better

*Trade-Marks Reg. U. S. Pat. Off. and Foreign Countries

Where there's a maze of piping...



...there's an amazing saving with SNAP*ON

With reports of savings from 20 - 50% on new G-B Snap*On pipe insulation, you can readily understand the enthusiastic reception it receives in refineries, natural gasoline plants, petrochemical and chemical processing plants.

Ease of applying these one-piece molded cylinders of fine glass fibers is the key to such substantial savings. Unlike segmental insulations, Snap*On comes in 6' sections, in sizes as large as 33", and is easy to apply even in crowded quarters.

For in-plant use, Snap*On is available plain or with canvas adhered for heated piping where temperatures do not exceed 350° F. and with adhered vapor jackets for chilled piping. For outdoor service, simply snap on Snap*On and cover with weatherproofing materials.

The bigger your plant, the bigger your savings when you use G-B Snap*On. You save on original installation . . . you save on maintenance, because Snap*On is rugged and permanent . . . you save heat, because Snap*On is superior in thermal efficiency to any similar product on the market.

Write today for sample and technical bulletin.

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Thermal and acoustical glass fiber insulations • Pipe coverings and fittings • Molded glass fiber pipe insulation

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where intolerance is a virtue!

Intolerance of salt in crude charging stocks is one of the first rules of refining efficiency. Many refiners advantageously desalt crude oils containing as little as 20 pounds per thousand barrels. With certain refining processes the salt tolerance is much lower. In general, the trend of permissible salinity is constantly downward.

Tretolite desalting removal percentages average between 95 and 100%, with many instances of 99 plus per cent removals. In spite of this excellent performance, the chemical cost of Tretolite desalting averages approximately 2 mills per barrel.

For complete information, ask the Tretolite refinery service engineer in your area or write to

TRETOLITE COMPANY

A DIVISION OF PETROLITE CORPORATION

369 MARSHALL AVENUE, ST. LOUIS 19, MISSOURI

5515 TELEGRAPH ROAD, LOS ANGELES 22, CALIFORNIA

These advantages of Tretolite desalting insure maximum desalting performance at minimum cost.

1. Low equipment cost
2. Simplicity of operation
3. Flexibility of operation
4. Efficient solids removal
5. Minimum operating attention
6. High percentage salt removal
7. Clean effluent water
8. Always available service

Chemicals and Services for the Petroleum Industry

DESALTING • CORROSION INHIBITING
DEMULSIFYING • SCALE PREVENTIVES
WATER DE-OILERS • ASPHALT ADDITIVES

TR 55-8

Extruded Incoloy tubes help keep gas reforming costs down. They are economical in cost and possess the necessary characteristics of strength, and heat- and corrosion-resistance. Shell reacts natural gas and steam in them at money-saving high pressures and temperatures.

How Incoloy reduces gas reforming costs in Shell's new anhydrous ammonia plant

High pressure, 1700°F reaction in extruded Incoloy tubes permits major operating economies

Today, anhydrous ammonia is cheap and plentiful . . .

A boon to dirt farmers in Southern California and Arizona. With it, they're growing big vegetables bigger than ever.

Shell Chemical Corporation makes this low-cost NH_3 in Pittsburgh, California and in its new plant at Ventura. They synthesize it from nitrogen plucked out of the air, hydrogen squeezed out of natural gas.

At the new plant, in the gas reforming stage, Incoloy* iron-nickel-chromium alloy helps Shell make several big economies.

Keeping the pressure high during the reforming operation results in a 25-30% saving in compressor horsepower when the synthesis gas is fed to the converters.

So Shell takes the natural gas at its high line pressure, heats it to 1700°F and reacts it with steam in extruded Incoloy tubes packed with catalyst.

This iron-nickel-chromium alloy provides the high creep and rupture strengths needed for this high temperature, high pressure reaction. It does not tend to suffer embrittlement as a result of phase changes. It resists oxidation and corrosive effects of the methane-steam mixture. What's more, the extruded tubes proved more economical than other materials considered for the application.

If your new developments include gas reforming at high pressures and temperatures, you may want to look into Incoloy. Just write Inco's High Temperature Engineering Section.

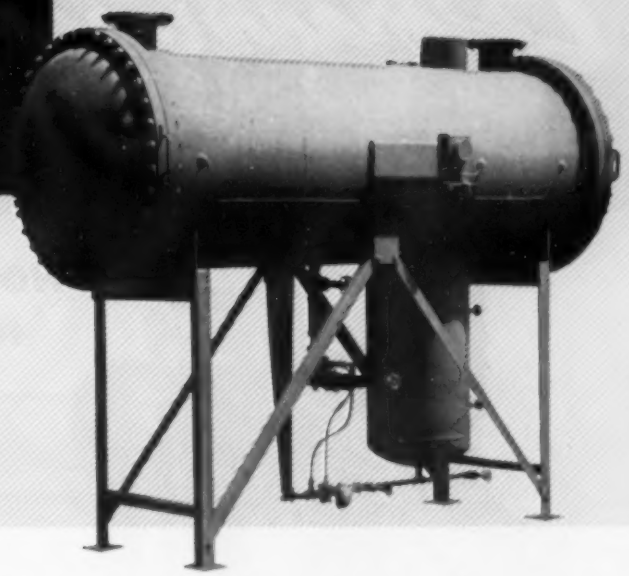
*Registered Trademark

THE INTERNATIONAL NICKEL COMPANY, INC.
67 Wall Street New York 5, N.Y.

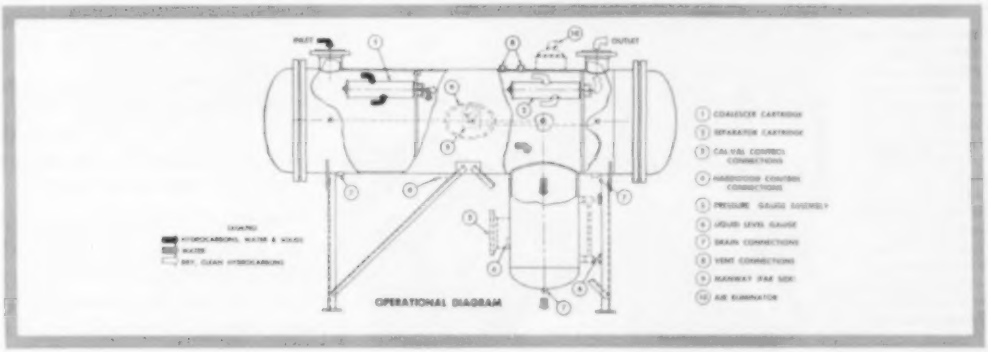
INCO Nickel Alloys

Incoloy . . . *"for long-life at high temperatures"*

FRAM
liquid separator filter



Removes the water cloud and solids from light petroleum products.



Here is the sure way to obtain clean, water-free petroleum products — the FRAM Liquid Separator/Filter is designed for use in refinery process streams and petroleum marketing installations to remove entrained water and solids (down to 5 microns) from gasoline, jet fuel, diesel fuel, kerosene, burning oils. Capacity is from 5 to 1000 GPM. Built to API-ASME Code. Send for Bulletin.

WARNER LEWIS COMPANY

BOX 3096 • TULSA, OKLAHOMA

DIVISION OF FRAM CORPORATION

Bingham STUFFINGBOXLESS PUMPS

HANDLE AT HIGH

FIREPROOF AND EXPLOSION-PROOF! Leakage of vapor or liquid to atmosphere or leakage from outside into pump is impossible. Not only is plant and personnel protected, but loss of valuable pumpage is prevented. Type KC High-Pressure Single-Stage Stuffingboxless Pump illustrated.

NO STUFFING BOX! NO PACKING!

Bingham Stuffingboxless Pumps are successfully handling liquids having high vapor pressure, requiring high suction pressure and, frequently, abnormally low pumping temperature (—300° F). Standard models handle suction pressures up to 2,000 psi (higher pressures available). Pumping temperatures to 850° F and higher also can be handled. These conditions present no difficulty for Bingham Stuffingboxless Pumps, but they are difficult and sometimes impossible to meet with conventional pumps due to limitations imposed by the stuffing box.

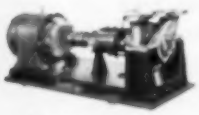
Because there is *no stuffing box*, Bingham Stuffingboxless Pumps eliminate all the disadvantages of conventional pumps operating with stuffing boxes equipped with packing or mechanical seals.

Bingham Stuffingboxless Pumps are in service today all over the world, with distinguished records in reliability, continuity of service, and low maintenance. Write to your nearest Bingham office for Bulletin 107 or for additional information.

***And other volatile liquids.**

TYPICAL BINGHAM "DOUBLE VOLUTE"

The Bingham Type HPD "Double Volute" Multi-Stage Double Case "Hi-Press" pump for extremely high pressure service.

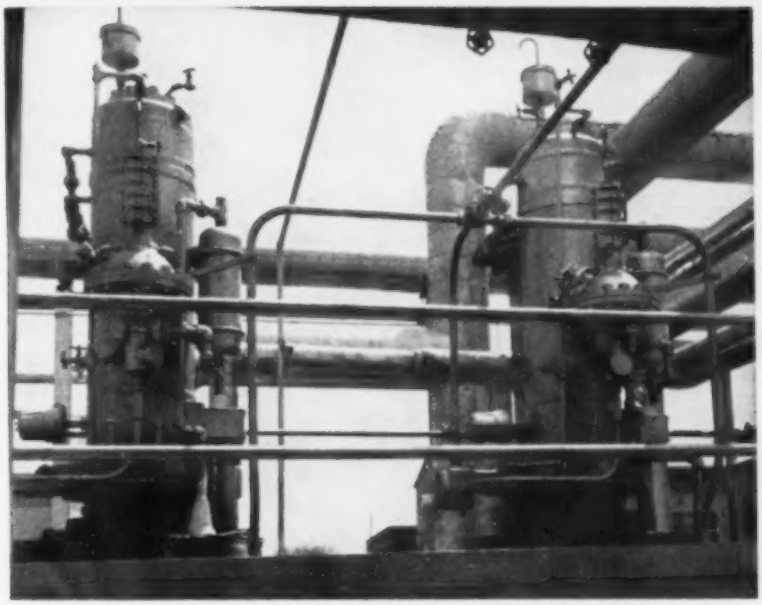


Bingham Type CAD "Double Volute" Single-Stage Process Pump.

Bingham Type CJ "Double Volute" Two-Stage Process Pump.

Bingham Type CD "Double Volute" Double Suction vertically-split case pump for hot service.

LIGHT HYDROCARBONS* SUCTION PRESSURES



Battery of Bingham Stuffingboxless Pumps handling light hydrocarbon at low temperature, under high suction pressure. Tennessee Gas Transmission Co. plant, Gobe, Kentucky.

Bingham SINCE 1921

DOUBLE VOLUTE PUMPS RADIAL BALANCE

BINGHAM PUMP COMPANY

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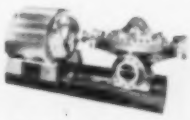
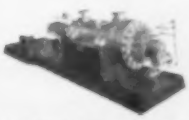
PUMPS FOR PETROCHEMICAL SERVICE

Bingham Type CM "Double Volute" vertically split case two-stage pump for hot service.

A Bingham Type CKA "Double Volute" Single Stage Koke-Krusher for coke-laden pumpage.



Bingham Type HSB "Double Volute" Double Suction Pump for high heads.



Bingham Type CP "Double Volute" Multi-Stage, Double-Case pump for hot or cold service.

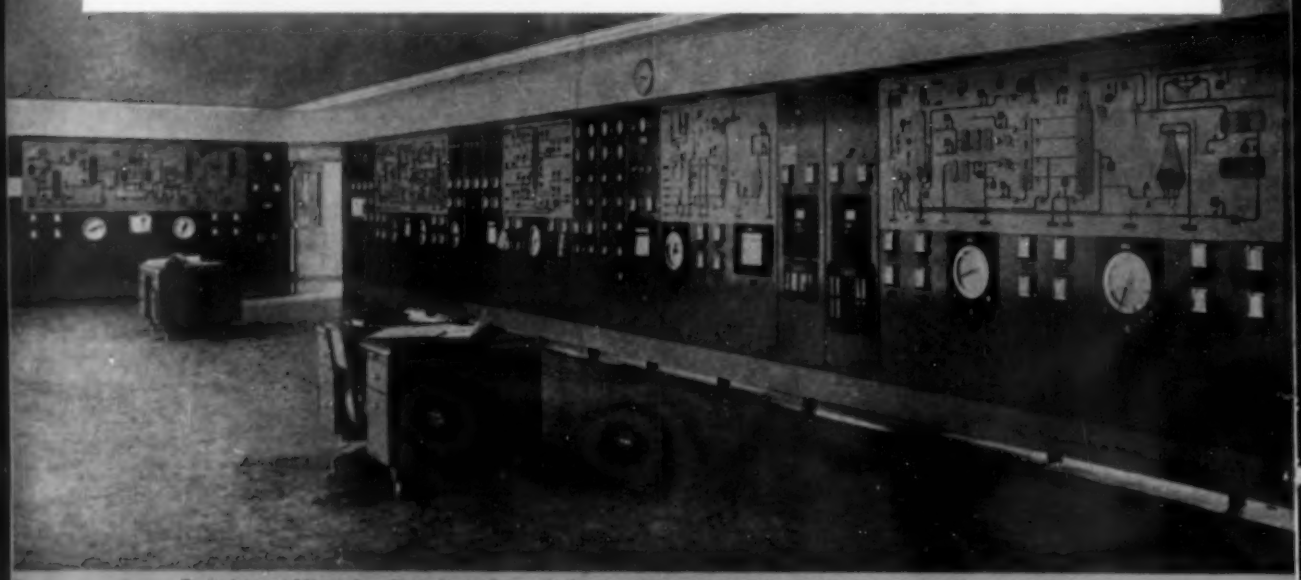
Bingham Type VCP Vertical Pump for low NPSH conditions, featuring bottom dismantling.

Automation is Over 21 —at M.W. Kellogg

Automatic control and instrumentation, which together have coined the new word "automation", are far from being new with The M. W. Kellogg Company. Largely through the work of the Instrument Section of Kellogg's Engineering Department, automation has long since come of age in petroleum refineries. It has been paying off for years in terms of increased production, higher quality, and in added safety and better working conditions.

In refinery control rooms, like the one shown below, every critical process variable is plotted, recorded, and observed at a glance . . . including temperatures, pressures, flow, and physical and chemical characteristics of the refinery process stream. Instruments now under development, using radioactive isotopes, can even peer through the heavy walls of high pressure vessels—and thus avoid the weakening of vital equipment caused when walls have to be drilled for conventional instruments.

The M. W. Kellogg Company's Instrument Section continues to work closely with all instrument manufacturers toward the development and application of systems which can improve refinery operations. It is an important part of the over-all service Kellogg can offer in designing your future petroleum or petrochemical facilities.



Control room of North Star Oil Limited refinery, St. Boniface, Manitoba—built by The Canadian Kellogg Company, Limited.

KELLOGG

REFINERY PROCESS DIVISION

THE M. W. KELLOGG COMPANY

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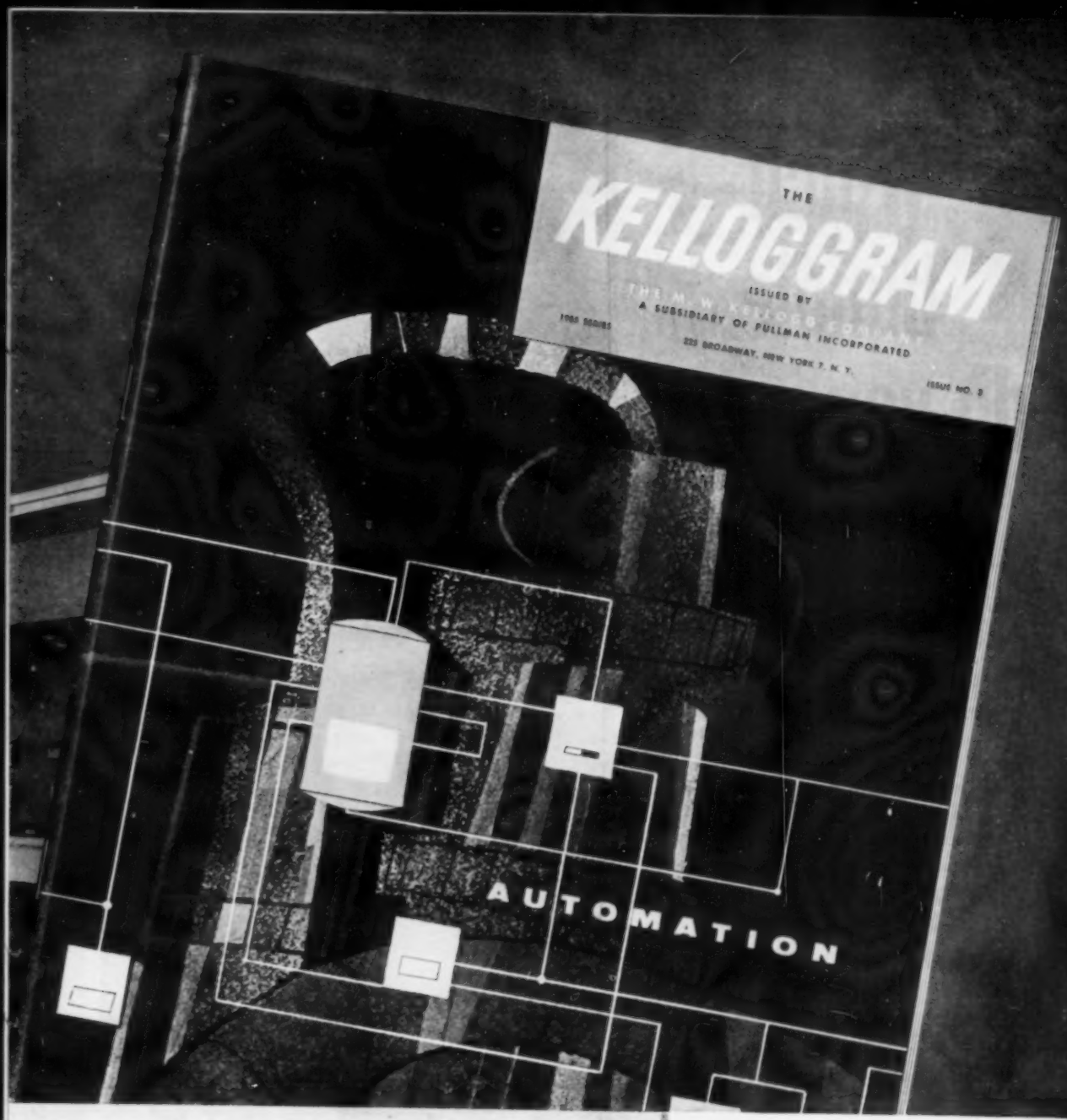

16-page booklet gives the facts

The M. W. Kellogg Company's No. 3, 1955 Kelloggram graphically explains, step by step, exactly what automation is, what it does, and how it can be employed by the petroleum refining and petrochemical industries to improve plant operating efficiency and product quality.

An easy-to-understand treatise of a highly complex subject, this 16-page booklet, illustrated with full-color diagrams, includes sections on gamma ray instruments, data reduction systems, electronic instrumentation, stream analyzers, and high pressure instruments.

A limited number of copies of this Kelloggram on automation are still available. The coupon will help expedite your request.

The M. W. Kellogg Company
225 Broadway, New York 7, N. Y.

Send copy of your 16-page Kelloggram (No. 3, 1955) which gives the complete story of automation and its application in petroleum refineries and petrochemical plants.

Name_____

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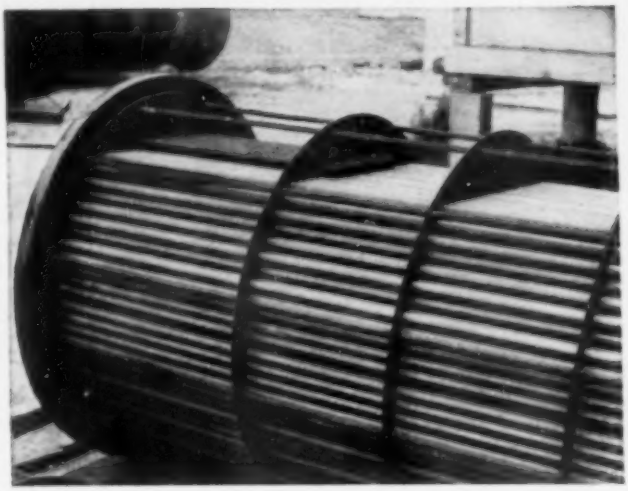
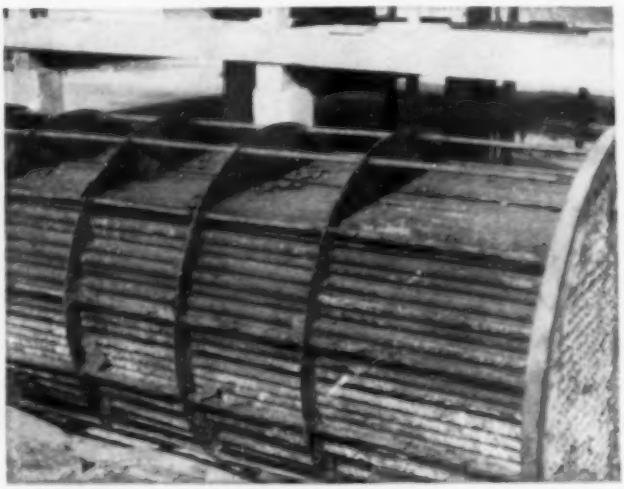
Which bundle do you want to find

at turn-around time?



This?.. Here's what a refiner likes to see when he pulls his bundles at turn-around time. This clean, uncorroded appearance is typical of what can be expected when you use Polyrad.



or this?.. This is an all too common sight at turn-around time. Corroded and fouled bundles such as these call either for costly replacement, repair, or cleaning.

These two bundles from the overhead condensing system of a Gulf Coast refinery tell a story. One is what the refiner likes to find at turn-around time; the other, what he is likely to discover without Polyrad.

More and more refineries have found that when they use Polyrad, the filming amine inhibitor, they can expect to find bundles free of corrosion, ready for immediate return to service. As a result turn-around time no longer need be headache time.

Why not make use of Polyrad's detergency to maintain throughput, increase heat transfer, and cut down time for maintenance?

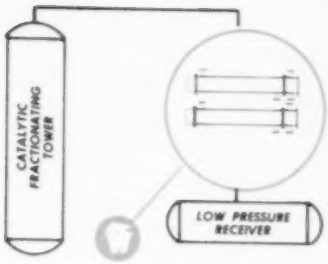
Stocks of Polyrad are maintained throughout the country. A Hercules technical representative will be glad to discuss its application to your operating conditions.

POLYRAD®

FILMING AMINE INHIBITOR

Pine Chemicals Division, Naval Stores Dept. **HERCULES POWDER COMPANY** *984 King Street, Wilmington 99, Delaware*

No. 11 in a series designed to help you achieve greater heat transfer efficiency.



NEW "CAT" FRACTIONATOR OVERHEAD CONDENSERS TUBED WITH

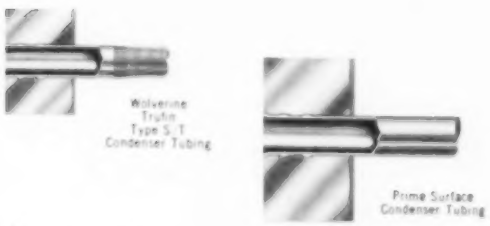
WOLVERINE TRUFIN* TYPE S/T CONDENSER TUBE

1

INCREASED EFFICIENCY—Trufin Type S/T is an extended surface tube with its fins an integral part of the tube wall. Because of this, Type S/T has more than two times the heat transfer surface of prime surface tube—extracts more BTU's per foot of tube. Shown here are comparable lengths of tube for equivalent heat transfer surfaces.

2

LOWER COST—Type S/T's additional outside surface area permits the use of less tube for a given heat duty. You get smaller shells, baffles, reduce fabricating costs with lower maintenance because there are less tubes to clean.



3

EASY INSTALLATION—Trufin Type S/T rolls into headers as easily as plain tube—uses the same fabrication methods. Standard rolling-in tools are used. There is no deviation from existing fabrication procedures.

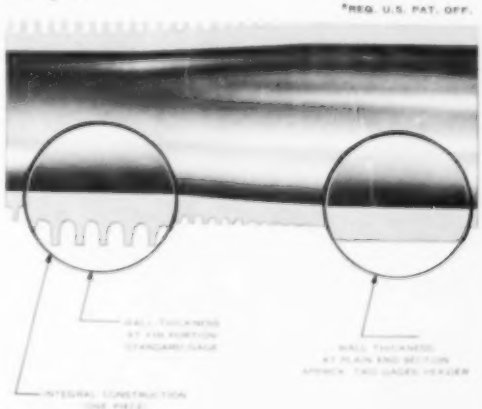
Because of Wolverine Trufin Type S/T condenser tube, new standards of efficiency and economy are daily being established in the field of heat transfer. Diagramed above is another Trufin installation—this time the condensing, for a large Midwest refinery, of hydrocarbon overhead vapors from a catalytic cracking unit fractionating tower.

Illustrated here are four solid reasons why this company specified Trufin Type S/T for the job.

Wolverine Trufin Type S/T will work exactly the same for you as it does for this company. Put it to the test—specify it next time you retube existing equipment or are contemplating the design of new units. Write today for your copy of the Trufin Opportunity Book—it's filled with dramatic case histories and helpful design information.

Wolverine Tube, 1441 Central Ave., Detroit 9, Michigan.

*REG. U.S. PAT. OFF.



4

ENGINEERED FOR THE JOB—Trufin Type S/T is specifically designed for shell and tube applications. The cutaway photograph illustrates its unique, one-piece construction. Because of this, Type S/T gives constant efficiency—its fins are unaffected by thermal shock, vibration or varying pressures.

WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

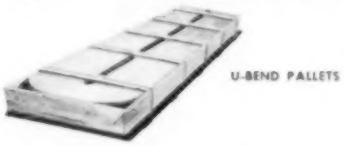
MANUFACTURERS OF QUALITY-CONTROLLED TUBING AND EXTRUDED ALUMINUM SHAPES

You Asked Us

Here are some of the questions which have been answered recently by Wolverine Field Engineering Service. It is active proof of Wolverine Tube's versatility.

Q • We changed our plant operation recently and now we're having severe corrosion problems. On one heat exchanger we have entirely different corrosion conditions on the shell side than we do on the tube side. What can we do to overcome this?

A • ***When two entirely different corrosive conditions are encountered, Wolverine can supply a Duplex tube—one which consists of two tubes of entirely different alloys. For example, a combination commonly used in water cooled ammonia condensers is an electric-welded steel outer tube with a liner of admiralty or copper. Any two metals can be used—the determining factor simply being the type of corrosion encountered. Of course, if you want more surface you can specify Duplex Type S/T condenser tubing. You not only get two different metals but also integral fins to increase the heat transfer surface.***



Q • Recently we used our first installation of Wolverine U-Bend condenser tubes. Can we obtain finned tube in U-Bend form?

A • ***You sure can. Wolverine U-Bends are available in both finned and prime surface condenser tube—pre-arranged to your prints.***

Q • On some jobs we've been using steel condenser tubing and there are a few cases where we'd like to obtain more surface. What do you suggest?

A • ***Actually you're in luck—On the exchangers where you want additional surface you can use Wolverine Trufin Type S/T welded steel condenser tubing. That will give you the surface you want. On those other heat exchangers where additional surface is not required you can retube them with Wolverine Qualitube*—our prime surface electric-welded steel condenser tube. You'll get long life plus a low-cost installation.***

Q • Can we use Wolverine Trufin Type S T condenser tubing at high temperatures?

A • ***Yes. Type S/T is an integral finned tube, as are all other types of Trufin. The fins are squeezed directly from the tube wall— are a part of the tube itself. They cannot shake loose because of thermal shock, vibration or varying pressures. Trufin is also available in bi-metal: high finned aluminum exterior and an inner liner of your choice.***

If you have a question—whether it be about alloys, design or fabrication—bring it to Wolverine. You'll get the right answer and you'll also get exactly the right condenser tube to help you do a better job. Write, too, for your copy of the Wolverine Condenser Tube Catalog. WOLVERINE TUBE, 1441 Central Avenue, Detroit 9, Michigan.

*REG. U.S. PATENT OFFICE

Wolverine Trufin is available in Canada through the Unifin Tube Company, London, Ontario.

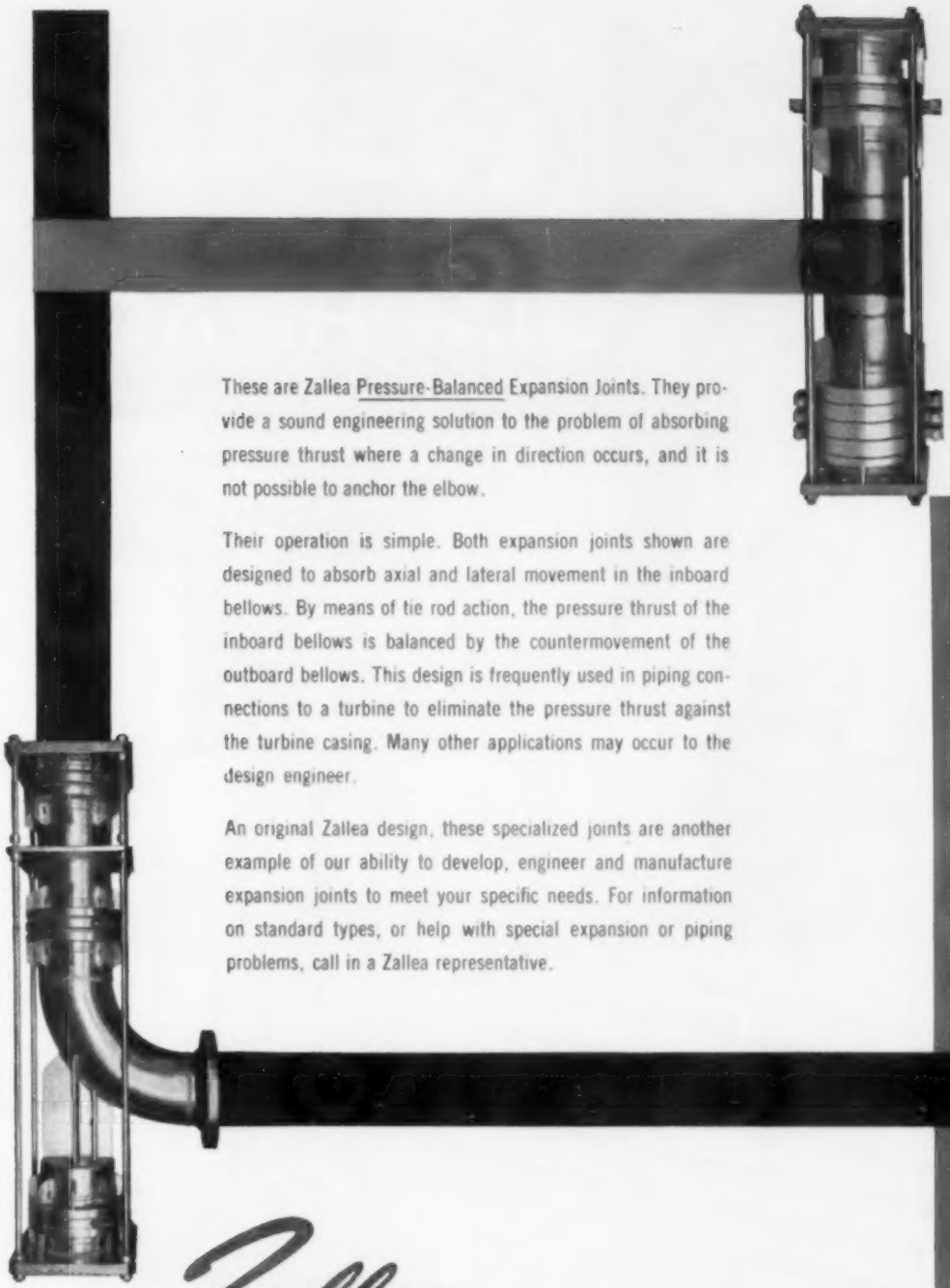
WOLVERINE TUBE

Division of Calumet & Hecla, Inc.

MANUFACTURERS OF QUALITY-CONTROLLED TUBING AND EXTRUDED ALUMINUM SHAPES

PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

EXPORT DEPT., 13 E. 40TH ST., NEW YORK 16, N.Y.



These are Zallea Pressure-Balanced Expansion Joints. They provide a sound engineering solution to the problem of absorbing pressure thrust where a change in direction occurs, and it is not possible to anchor the elbow.

Their operation is simple. Both expansion joints shown are designed to absorb axial and lateral movement in the inboard bellows. By means of tie rod action, the pressure thrust of the inboard bellows is balanced by the countermovement of the outboard bellows. This design is frequently used in piping connections to a turbine to eliminate the pressure thrust against the turbine casing. Many other applications may occur to the design engineer.

An original Zallea design, these specialized joints are another example of our ability to develop, engineer and manufacture expansion joints to meet your specific needs. For information on standard types, or help with special expansion or piping problems, call in a Zallea representative.

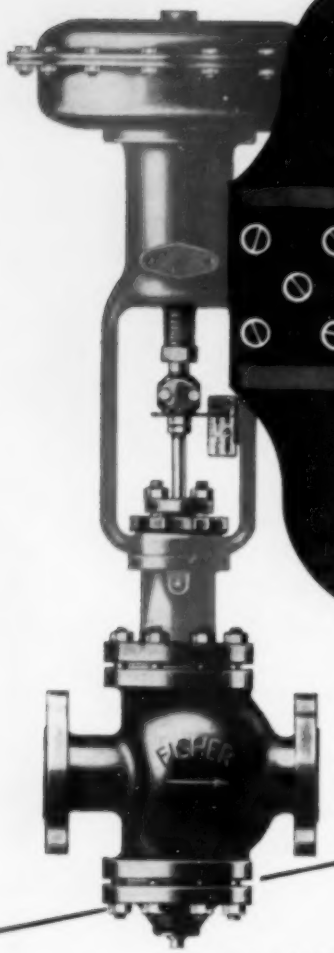
Zallea *expansion joints*

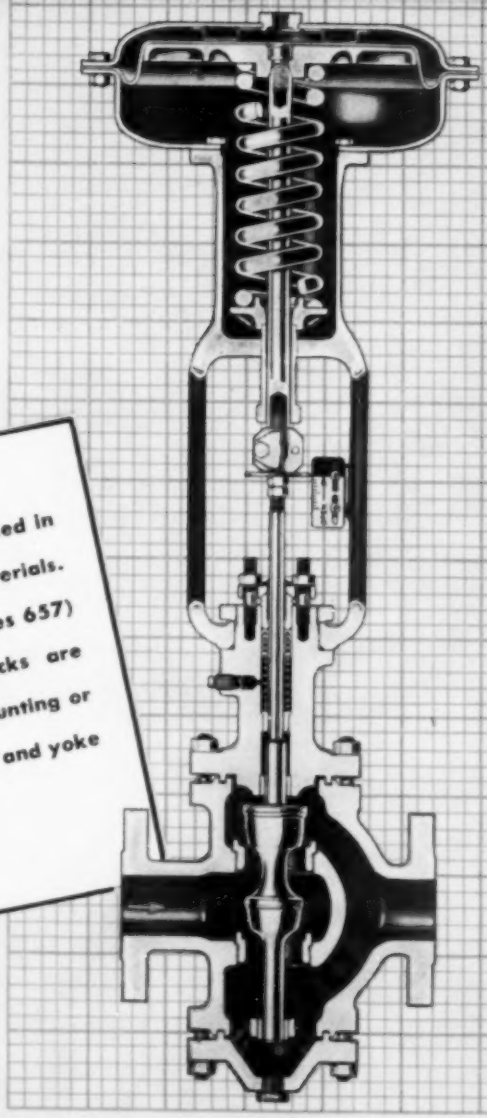
ZALLEA BROTHERS 822 LOCUST STREET, WILMINGTON 99, DELAWARE

World's Largest Manufacturers of Expansion Joints

FISHER®

DIAPHRAGM





● Fisher Diaphragm Motor Valves are furnished in a wide variety of pressure ratings and materials. Topworks may be either direct acting (Series 657) or reverse acting (Series 667). Handjacks are available for either diaphragm casing mounting or yoke mounting. There are six diaphragm and yoke size combinations.

Improved

MOTOR VALVES

Improved PERFORMANCE FEATURES

- Bolted-clamp type stem connection allows stem adjustment of 50% of total travel. Can be disconnected in the field without stem damage. Will not shake loose from vibration or rotational inner valve forces.

- Rugged body to yoke connection with hammer lug nut. Topwork can be removed without disturbing stuffing box.

- Specially designed Buna N molded diaphragms with Nylon insert retain superior flexibility at low ambient operating temperatures. Provides linearity between operating pressure signal and travel, and gives maximum effective area.

- Bolted gland stuffing box with Teflon packing.

- Stainless steel clear view travel indicator.

- Spring ranges: 3 to 15 psi; 6 to 30 psi.

FISHER GOVERNOR COMPANY • Marshalltown, Iowa

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

FISHER

Our 75th ANNIVERSARY

This falls...

WARM DAYS...
COLD NIGHTS...

TAKE A DAILY "PUNCH"

AT THE PEP IN YOUR MOTOR FUEL

ADDING WARREN NATURAL GASOLINE TO YOUR PRESENT HIGH QUALITY MOTOR FUEL WILL GIVE IT THE

RETAINED VOLATILITY

SO NECESSARY FOR SUPERIOR PERFORMANCE... IN ANY SEASON

Warren's production, transportation, storage and service are your assurance of the quality and quantity of NATURAL GASOLINE you need . . . when and where you want it.

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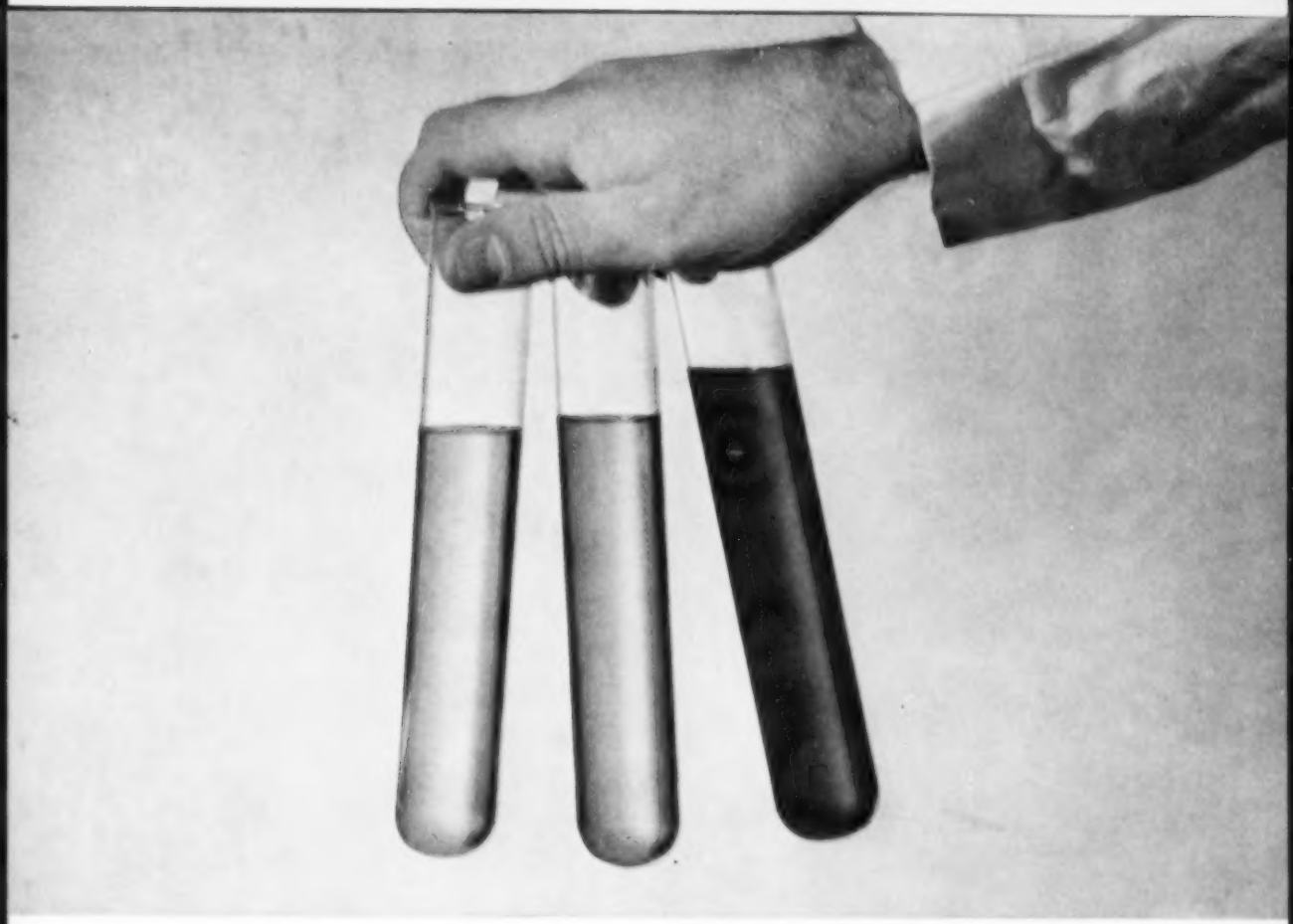

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FUEL OIL STAYS CLEAR

This blended straight-run and cat-cracked fuel oil was refined in Texas. Unstabilized, it degraded to N.P.A. Color 4.0 after tanker shipment to New York and subsequent 4 months storage. How the same oil, Nalco stabilized, withstood the trip and storage is dramatically shown in the unretouched color photo, above.

At left, a refinery fresh sample has N.P.A. Color 1.5. Center, Nalco-stabilized sample has N.P.A. Color 2.0 after 4 months. Right, untreated sample has N.P.A. Color 4.0 after 4 months.

Here is real Nalco protection against color degradation . . . protection that has the bonus value of effective sludge prevention. Nalco Fuel Oil Treatment adds up to *better fuel oil salability*, regardless of fuel types, storage or handling problems. Full data are available, now. Call or write for Technical Data Sheets on Nalco stabilizers.

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Nalco®

PRODUCTS...SERVING INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

sulfur in petroleum analyzed
better than twice as fast with Lindberg Unit!

This new Lindberg High Frequency Combustion Unit has been developed to provide a much more *rapid* analysis of sulfur in petroleum products. The unit is now being used by major refiners all over the country.

Its flexibility and speed make possible its application to a wide variety of petroleum products with boiling points above 300° F. including diesel fuel, kerosene, oil sludges, lubricating oils with additives, tars and asphalt.

Compact: This unit is conveniently compact, requiring a minimum of laboratory space.

Ready: Unit always ready for instant use. Only once-a-day warmup (just 57 seconds).

Cool: Only the samples are heated. There is no excess heat in laboratory.

Economical: "Vycor" glass combustion tube costs half as much, lasts longer and permits easy visibility.

Laboratory Supply Dealers can now make early shipments of this new Lindberg LI-500P "H-F" Combustion Unit. Write for bulletin No. LEP-1, or get in touch with your dealer for this and other quality Lindberg Laboratory Equipment.

G-10 3000° Furnace

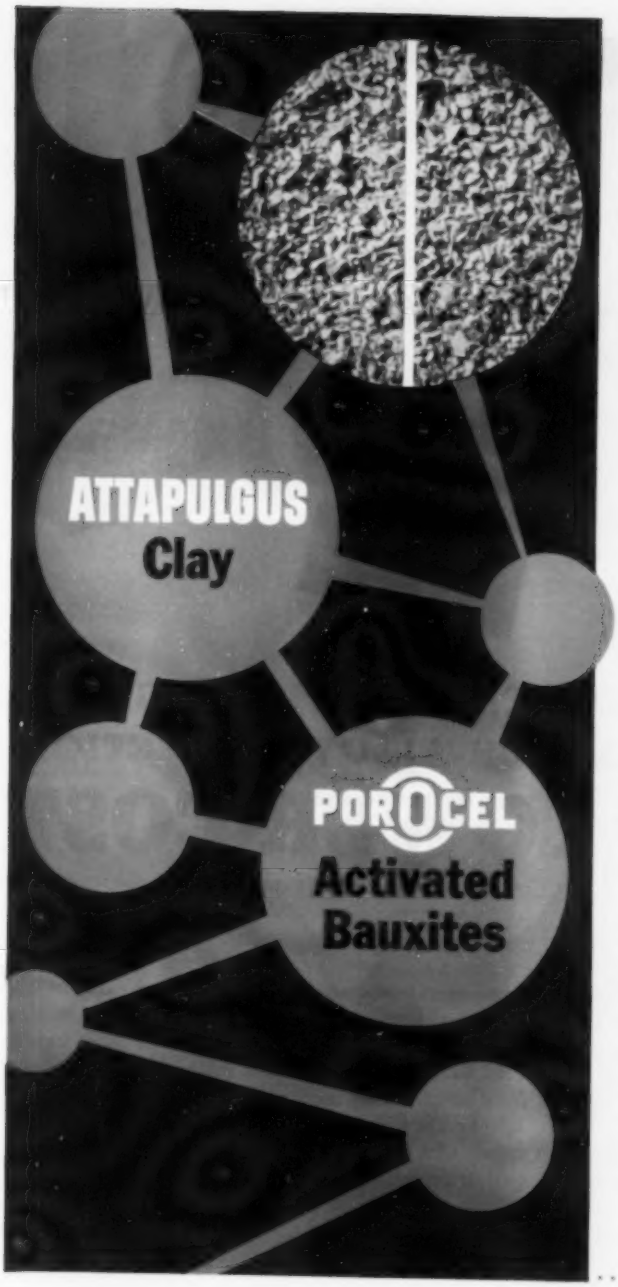
M-2 Hot Plate

H-88 Hot Plate

B-6 Box Furnace

LINDBERG LABORATORY EQUIPMENT

Laboratory Division, Lindberg Engineering Co., 2481 West Hubbard St., Chicago 12, Ill.



Here's the way to tackle a sorptive-mineral job

Away up in number two slot in a list of nearly 2,000 different chemicals used in petroleum refining operations is *sorptive minerals*. And the adsorbents recognized as standards in the industry are Minerals & Chemicals products—Attapulgus Clay . . . Porocel Activated Bauxites. That means there's a *headquarters* to turn to!

Want To Purify By Adsorption? There's an M&C adsorbent to fit your process scheme for removing odors, colors, taste, moisture, acids, sulfur compounds, fluorides and unsaturates from process liquids or gases.

Catalyst Carrier? M&C sorptive minerals are of highest importance in a wide variety of hydrocarbon conversion and sweetening processes.

What Do You Want To Dry? M&C offers a complete line of reliable desiccants for drying air, hydrogen, CO_2, hydrocarbon liquids and gases.

HERE'S THE NEWEST APPLICATION *of sorptive minerals in the petroleum field. Mail the coupon for your free copy of "Preparation of Petroleum Feeds for Platinum Catalysts"— and for other assistance if desired.*

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☐ Please send me "Preparation of Petroleum Feeds For Platinum Catalysts."

☐ Please provide technical help (and samples) on the following proposed applications: _____

_____

name _____ title _____

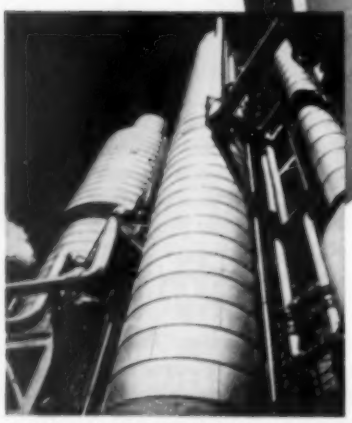
company _____

address _____

city _____ zone _____ state _____

 (To obtain more data on advertised products see page 1800)

STRUCTURAL STABILITY—
Low-cost carbon steel backing provides necessary strength and rigidity.
DESIGN FREEDOM—
Integral bond allows design and fabrication of shapes to meet process and space needs.
ECONOMY—
High-alloy layer assures corrosion resistance, long equipment life.



Stainless-clad and monel-clad steels combine to handle corrosive asphalt crude containing up to 2.5% sulfur concentrations at 750° F in this vacuum still.

CLAD STEEL EQUIPMENT GIVES SOLID HIGH-ALLOY PROTECTION AT LOWER COST

With protection against the corrosive action of sulfuric feeds at high temperatures a "must" to avoid unscheduled shutdowns, clad steel equipment is often the *economical* answer. Cladding and backing are permanently and integrally bonded over their entire surface, eliminate the chance of seepage or crevice corrosion. Smooth, uniform clad surfaces permit easy cleaning, drainage and inspection.

Why not investigate clad for your new processing equipment. Lukens Clad Steels—stainless, nickel, Inconel, Monel, copper—give you all the advantages of these solid high-alloys with savings up to 50% in material costs.

In addition to low first cost, clad steel permits easy and economical field erection. When you're thinking of new tanks and pressure vessels, *qualified* equipment builders can help you take advantage of the versatility of Lukens Clad Steels. Working with your engineers and consultants from the start, they tailor equipment to your exact needs. We offer the widest range of clad steels available and work closely with fabricators to help select the type most suited to your processing needs. If you would like further information, ask one of your builders or write Manager, Marketing Service, Lukens Steel Company, 752 Lukens Building, Coatesville, Pennsylvania.

LUKENS **CLAD STEELS**

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PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE

THREE NEW MODELS

DH-10
NEW DH-15
DH-20
NEW DH-25
DH-30
NEW DH-35
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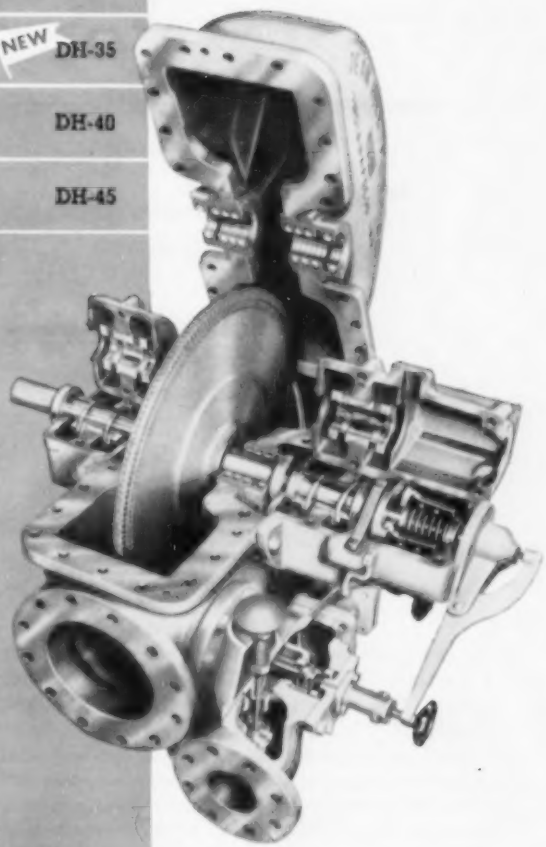
NOW YOU CAN CHOOSE FROM 8 MODELS TO MEET YOUR WORKING REQUIREMENTS



expand DH steam turbine line

The latest in a long series of advancements in the Dean Hill line of horizontal steam turbines is the addition of three new turbines introduced as intermediate models. These new models effect a more gradual increase in power ratings in the horizontal line. The reduced "spread" between ratings in the new 8-model line gives you a better opportunity to match the turbine to the job within a very close margin. Of course, this is always to your advantage in turbine selection.

Because the new models incorporate all the newest improvements made on the other sizes, the Dean Hill horizontal line is one of the most *advanced*, *complete* lines in the world. With single-stage construction and sleeve bearings, they are specifically designed to operate at medium steam pressures. Low power consumption results in outstanding operational economy of every model in the line.

Write for Catalog No. 500 for details on both vertical and horizontal DH turbines. Information includes cut-a-way illustrations, detailed line drawings, tables, horsepower curves.

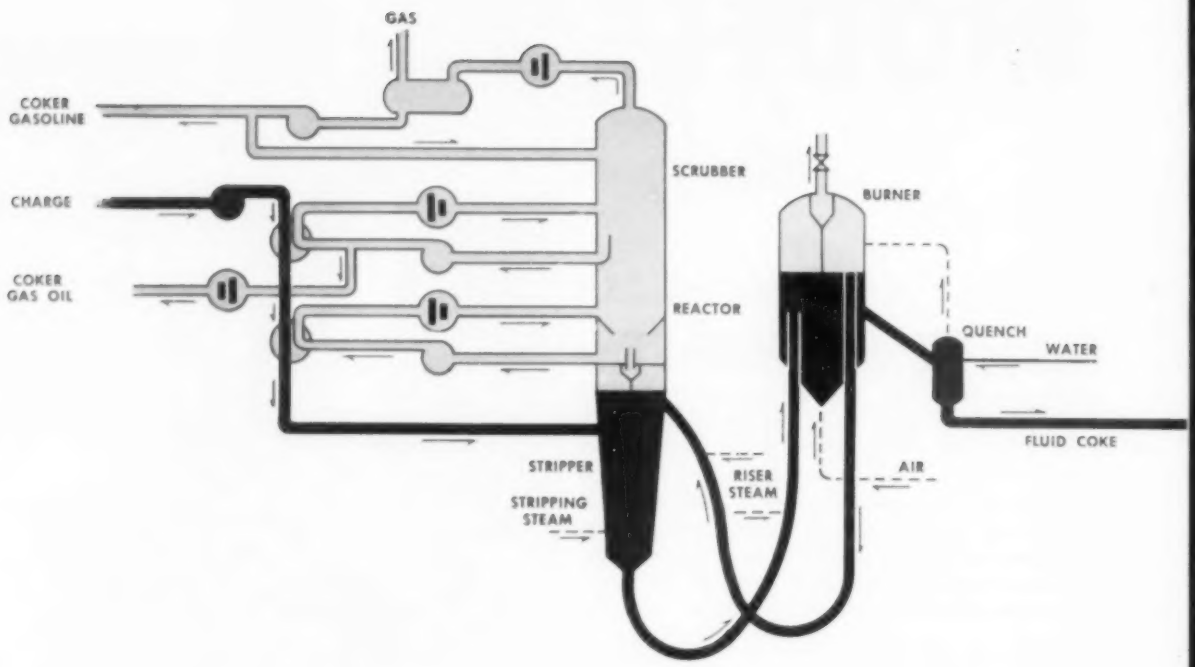
DEAN DH HILL PUMP COMPANY

Pump and Turbine Engineers Since 1893
Indianapolis 7, Indiana

Sales Offices In:
Chicago, New York, San Francisco, Boston, Cincinnati, Denver, Albuquerque, El Paso, Salt Lake City, New Orleans, Philadelphia, Tulsa, Los Angeles, Pittsburgh, Houston, Dallas, St. Paul, Toledo, Cleveland, Grand Rapids, Birmingham, Ala., Memphis, Richmond, Mexico City, Montreal, Reading, Pa. The Hague, Washington, Charlotte, Casper, Wyo., Knoxville.

fluid

its production...



IN THIS latest application of the fluidized-solids technique, developed by Esso Research and Engineering, heavy residua and asphalts can be converted to gas, oil and coke.

As shown in the flow diagram above, finely divided coke particles flow between two vessels—a burner and a reactor. In the burner, part of the coke stream is burned to supply the heats for vaporization, cracking and losses. When this hot coke meets the feed in the reactor, coking results and the liquid products are flashed off.

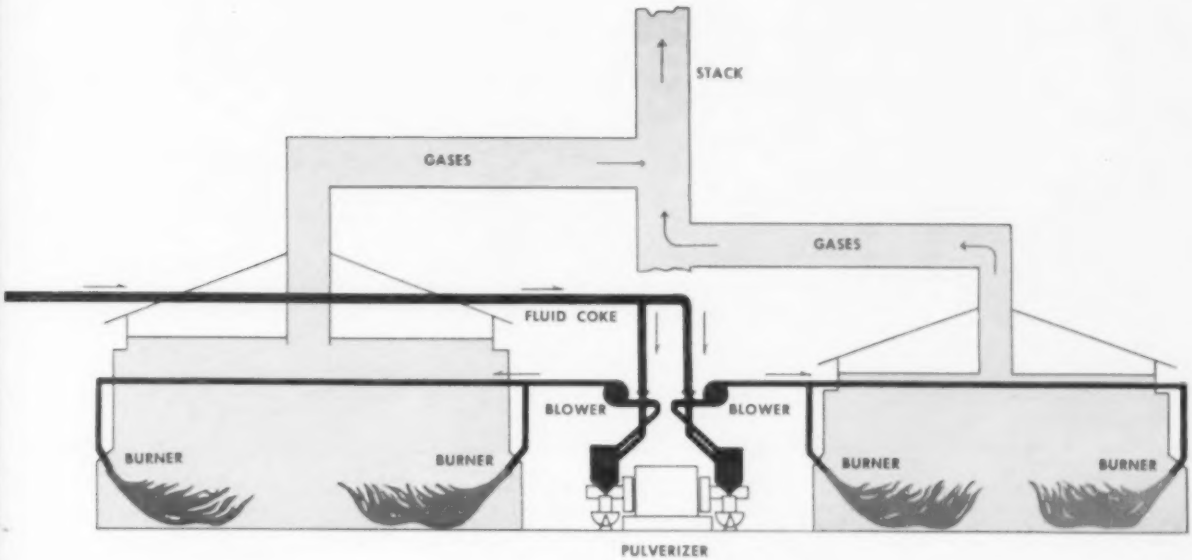
Coke particle size ranges between 75 and 150 microns and the coke itself is a clean, dustless solid. The feed is preheated through two fractionator (scrubber) pump-around systems. In the reactor it contacts the hot coke flowing from the burner. Coke is formed as the fluidized bed moves down into the stripper section where steam removes any remaining volatiles. The stripped coke then flows into the burner where, in contact with air, approximately 5 per cent by weight of the charge is burned. The coke inventory in the unit is fixed and the excess is removed as product coke which is cooled by water spray before flowing to storage.

The vapors from the reactor pass into the scrubber-fractionator section where they are separated into gas, gasoline and gas oil.

FOSTER

coke

...and utilization



THE USE of fluid coke as a fuel is illustrated in the above simplified diagram of two heaters designed by Foster Wheeler for a large oil company. They will supply the heat requirements for the atmospheric and vacuum sections of the highest capacity crude distillation unit in the world, having a combined heat absorption capacity of 336,400,000 btu per hour.

The pulverizers which reduce the particle size of the fluid coke before it is burned in the furnaces, as well as the pulverized coke burners, are also of Foster Wheeler design.

Designs are also available for the burning of fluid coke in steam generators.

Foster Wheeler's experience in the design of equipment for both the *production* and *utilization* of fluid coke will be of value to any process plant interested in converting heavy residua into cracking stock and making effective use of the resulting solid fuel. For further details on this process, or for proposals to meet your specific requirements, write to *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

FW WHEELER

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NEW YORK
PARIS
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NEED EXTREME DRYNESS?

ALCOA Activated Alumina dries to lower dew points than other commercial adsorbents

TYPICAL PROPERTIES OF DESICCANT GRADES ALCOA ACTIVATED ALUMINAS

CHEMICAL ANALYSIS, %	F-1	F-3	F-5	F-6	H-151
Al_2O_3	92	92	77	86	85
Na_2O	0.80	0.80	0.70	0.76	2.0
Fe_2O_3	0.12	0.12	0.10	0.11	0.15
SiO_2	0.09	0.09	0.08	0.08	6.3
Loss on Ignition 1100°C (2012°F)	6.8	7.2	12.4	8.5	6.2
$CaCl_2$	.....	.....	9.3	.....	.....
$CoCl_2$	.....	.....	.....	2.0	.....
PHYSICAL PROPERTIES					
Form	Granular	Granular	Granular	Granular	Ball
Surface Area, meters²/g	210	200	.....	200	350
Bulk Density, Packed, lb/ft³	55	55	60	57	55
Bulk Density, Loose, lb/ft³	50	50	55	52	52
Specific Gravity	3.3	3.3	.....	.....	3.1-3.3
Dynamic Sorption*	13-15	11-13	18-23	13-15	21-23
Crushing Strength†	55	55	.....	.....	60
Pore Volume, ml./g	0.25	0.25	.....	0.25	0.3
Pore Diameter, Å	40	40	.....	40	50
Static Adsorption at 60% Relative Humidity, %	13.0 (Min.)	11.0 (Min.)	.....	.....	20.0 (Min.)

The standard sizes for F grade alumina are ½" to ¼", ¼" to 8 mesh and 8 to 14 mesh. Other nonstandard sizes from 2" granules to 325 mesh powder are available. Activated Alumina H-151 is available in nominal ⅛" and ¼" diameter balls.

*Adsorption of moisture at 100% efficiency from air under isothermal conditions at 30°C and 84% relative humidity under dynamic flow of 7.5 cu ft/hr/lb *Activated Alumina—Its Properties and Uses.*
†Method of *Activated Alumina—Its Properties and Uses.*

ALCOA® Activated Aluminas are among the most effective and efficient desiccants available for the dehydration of liquids and gases. Dew points as low as minus 100°F—and even lower—may be obtained, and under normal circumstances, ALCOA Activated Aluminas can be used for an almost indefinite number of drying cycles.

Besides their use for dehydration, ALCOA Activated Aluminas adsorb certain gases and vapors from gaseous mixtures and serve as catalysts and catalyst carriers. They are used in the liquefaction of gases, and for the maintenance of transformer and lubricating oils.

Let us tell you more about these efficient desiccants, and supply you with samples. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 716-L Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA

Prevent this Waste!

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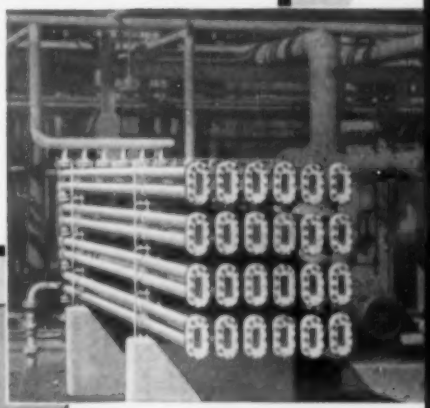

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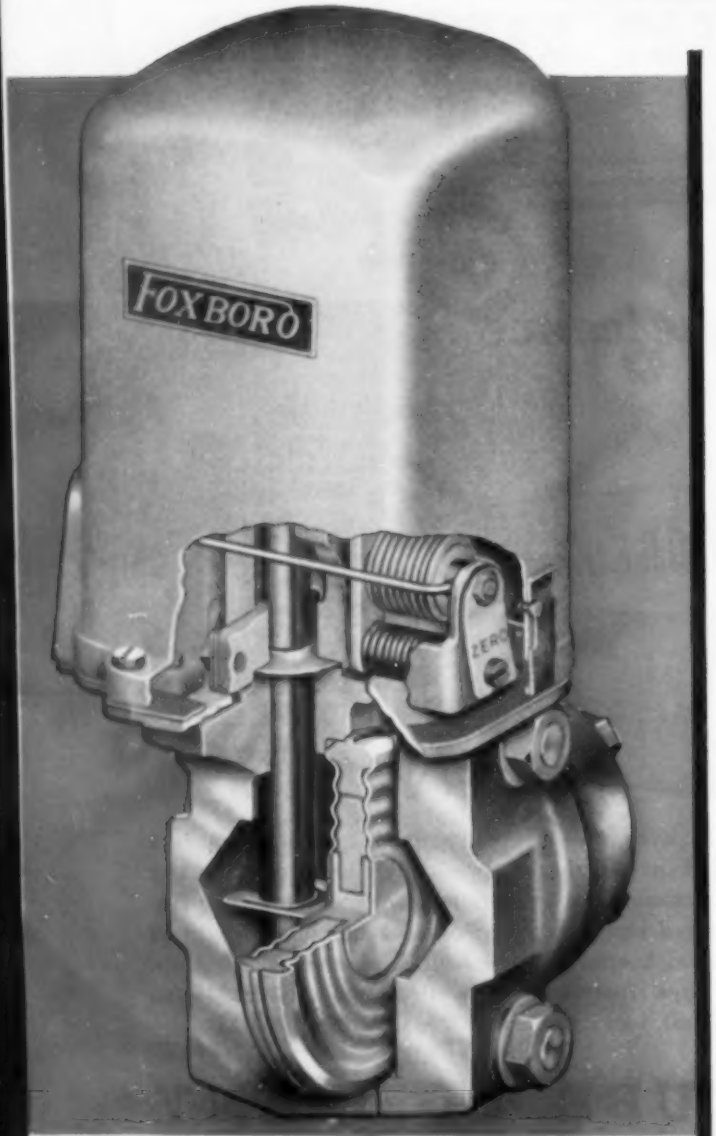

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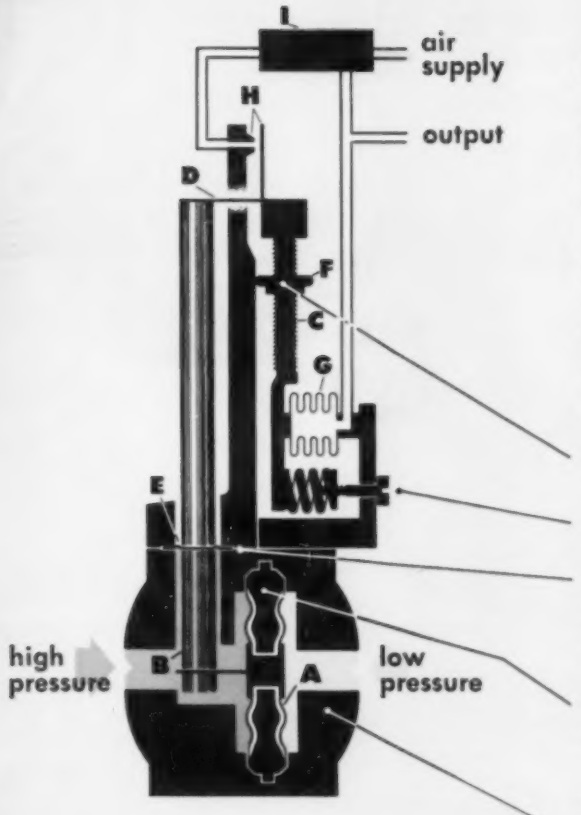
Cell Flow Transmitter

design features...



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An increase in differential pressure across Twin-Diaphragm Capsule (A) exerts force to right on force bar (B). Elgiloy® diaphragm seal (E) acts as fulcrum. Force to left at top of bar (B) causes flapper to approach nozzle at (H). Resulting increase in nozzle pressure is amplified by relay (I). This pressure is sent to feedback bellows (G) which develops force to counterbalance the differential pressure on capsule (A). The 3-15 psi output signal from relay (I), always precisely proportional to differential pressure, is transmitted to remote recording or controlling instrument.

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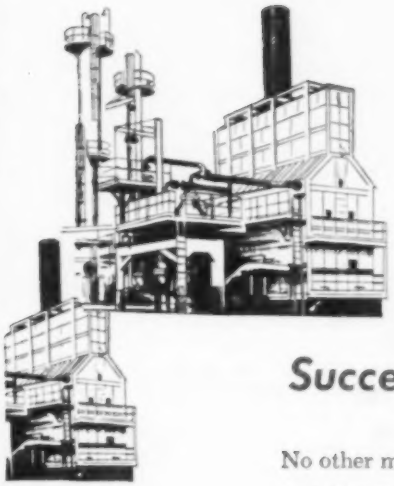

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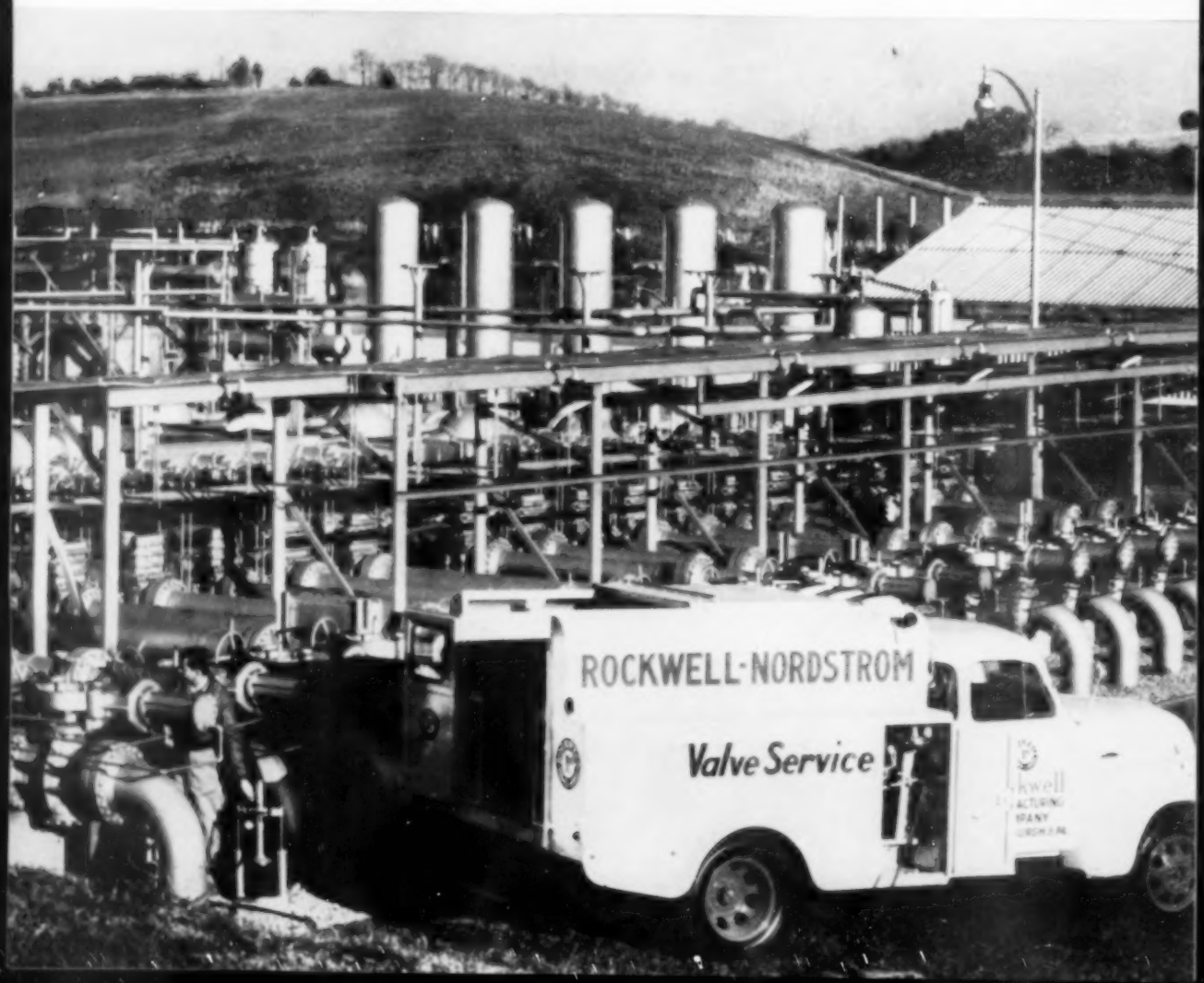

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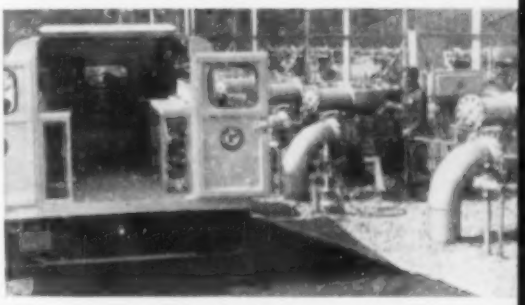

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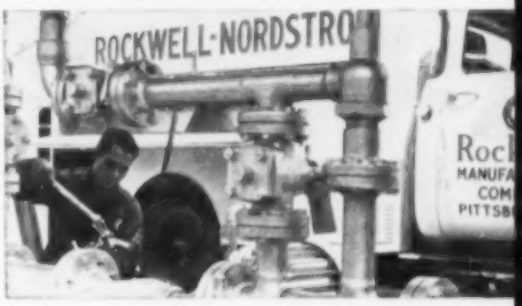

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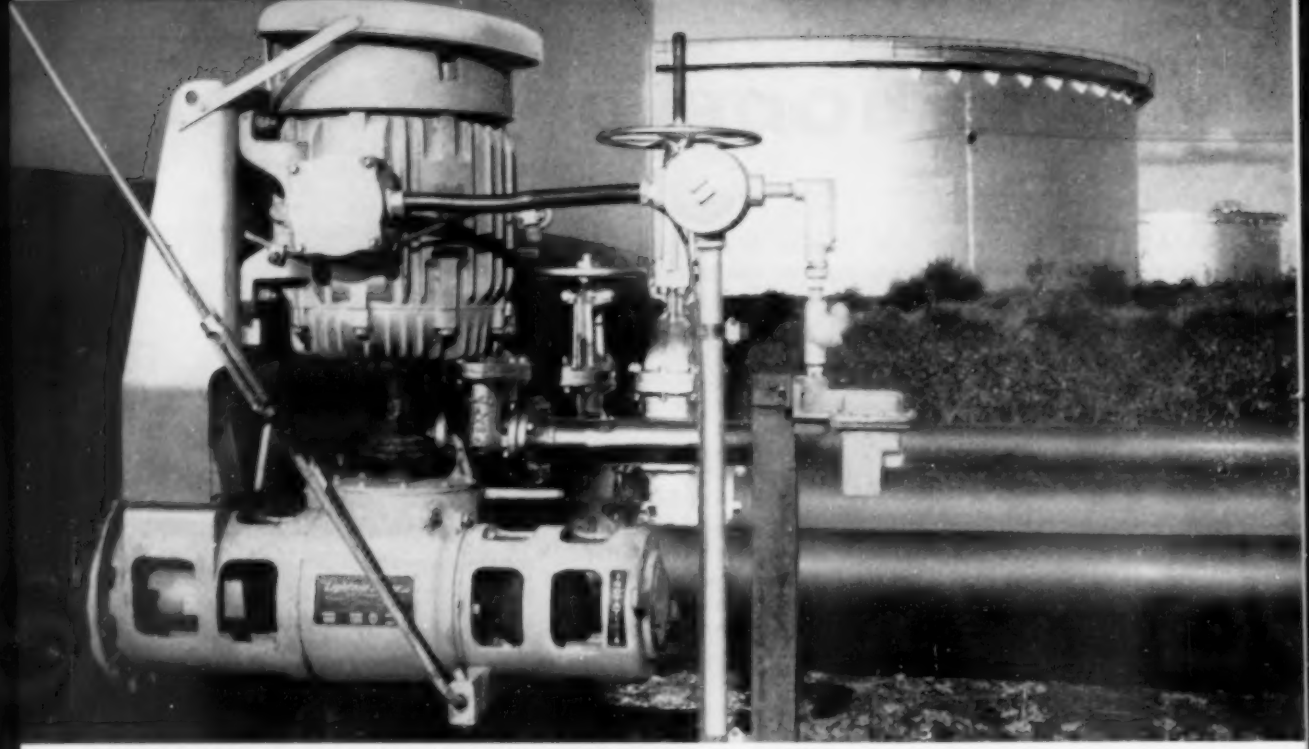

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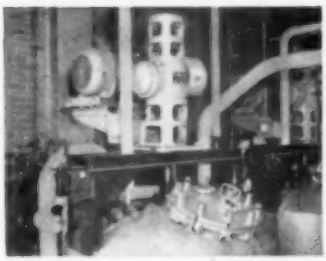

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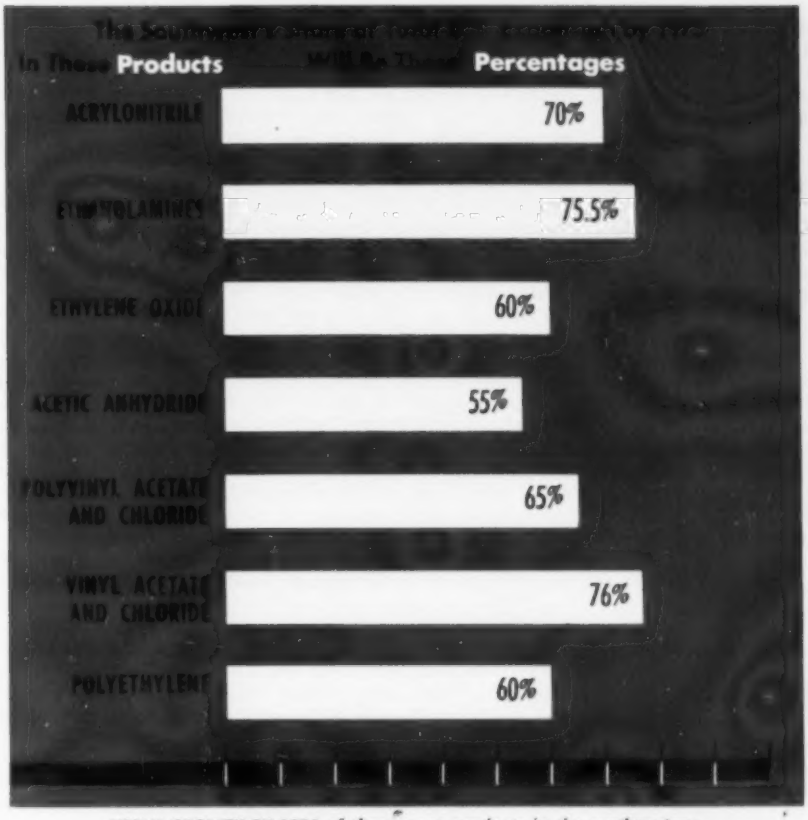


HEAVY GROWTH BY 1975 of these seven products in the southwestern United States is one key factor showing that . . .

In Petrochemicals . . .

Southwest Will Stay Dominant

By V. B. GUTHRIE
Associate Editor

THE petrochemical picture for the southwest is still solid.

Along with the expansion anticipated by 1975 as charted for seven important materials as shown above, a study of natural gas petrochemical potential both in the southwest and in the rest of the country has brought out the following:

- The use of low cost water transportation of large tonnage products, where possible, together with large-scale plant operations, will tend to offset the trend to higher gas prices and make the Gulf Coast area a desirable location for new petrochemical plants.
- Locations on inland waterways at some points in the Southwest will combine the advantages of low cost water transport of product and low transport cost for the natural gas raw material.
- Some expansion in natural-gas based petrochemicals will occur near major urban market areas,

where there are power cost advantages and where there is a lower cost factor for chemicals used in processing. The Ohio Valley particularly qualifies as a desirable market-gateway point for the location of chlorinated petrochemicals plants.

• The major portion of the expansion to 1975 in the gas petrochemicals will take place in the natural gas producing areas although the degree of concentration may not be as large as at present.

• Production will tend to become more and more associated with large-scale plants.

These conclusions relative to plant expansions were developed in a study of location factors in the petrochemical industry made by the Massachusetts Institute of Technology. Their study was part of a survey of the general industrial and economic possibilities of the Arkansas-White-Red River basins, in the Southwest, sponsored by the U.S. Department of Commerce. The nature of the petrochemical industry is such that the survey in this field was made on a nation-wide basis. Hence the petrochemical plant location factors discussed have general application.

The report on location factors in the petrochemical industry was prepared by Professor Walter Isard and Eugene W. Schooler, of the Urban and Regional Studies Section, Department of City and Regional Planning, of MIT. A group of engineers with oil companies and refinery construction firms cooperated in the preparation of the report. (A first article on the study was published in the October PETROLEUM PROCESSING, pp. 1587-1591.)

The product volume expansion in the petrochemical industry was also studied by the MIT and industrial authorities and data prepared on U.S. plant capacity by 1975, as well as the volume of output of the principal individual natural gas petrochemicals.

U.S. plant capacity for these gas petrochemicals will total nearly 56 billion lb/yr. by 1975, it is estimated. Plant capacity in the Gulf Coast region, which was early a concentrated area for petrochemical production, will expand by over 8 billion lb/yr. from 1950 to 1975, and that in the AWR region by about 4.5 billion. Expansion in the U.S. outside these geographical areas will be nearly 19.5 billion lb/yr. in this period.

Many individual petrochemicals by 1975 will be produced at the rate of over 1 billion lb/yr., principally those going into end uses in the manufacture of plastics, synthetic fibers and synthetic rubber. Acrylonitrile, for example, production of which was only 25 million lbs in 1950, is expected to expand to a yearly output 1.3 billion lbs by 1975; polyethylene from 50 million to 1 billion by 1975; GR-S rubber from 800 million to nearly 3.5 billion; ethylbenzene from 652 million to nearly 3.2 billion.

It is further estimated that the utilization of all petroleum and natural gas hydrocarbons for conversion into chemicals will be over 28 billion lbs.

Detailed data on the coming expansion in plant capacity for natural gas petrochemicals and on the utilization by 1975 of the primary petrochemicals are shown in the accompanying tables.

In analyzing the distribution of individual petrochemical expansions among the areas served by natural gas, the investigators recognized that distribution of markets is a critical factor. And, with petrochemicals, the determination of the geographic distribution of markets is complicated. "One petrochemical feeds into another," it was stated, "and, ultimately, into non-petrochemical products, some of which, in turn, feed into still other non-petrochemical products." Lacking a better alternative, it was postulated that the future geographic expansion of petrochemicals would correspond to the current geographic distribution of population.

Aside from the distribution of markets, the chief factors in determining individual petrochemical plant locations were considered to be the transport cost of raw materials and products and the scale of plant operations to be achieved. Other factors, such as the basis for raw material, plant investment, labor and operating costs were considered as not fluctuating enough to be prime factors in plant location.

An analysis of ethylene glycol operations by both the oxidation and chlorhydrin processes served as a pilot plant guide in setting up the formula for estimating petrochemical plant expansions. The report states, "we could roughly determine the geographic distribution of the market for that portion of ethylene glycol which enters into anti-freeze production by observing the geographic distribution of cold weather population. Also, we had some information on the future geographic distribution of "Dacron" production which was helpful in estimating the geographic pattern of expansion of ethylene glycol

Expected Growth in 25 Petrochemicals From Natural Gas

(1950-1975, by geographical regions and U.S. total; capacity in millions of lbs. Annually)

Regional and U. S. Expansion by 1975

Product	1950 U.S. Production[1]	Ark.-White Red River Region	Gulf Coast	Remainder of U.S.[2]	Total Expansion[2]	Estimated Total U.S. Cap. 1975[2]
Ethylene Glycol	520	145	267	358	770	1,290
Acrylonitrile	25	251	641	383	1,275	1,300
Ethanolamines	33	33	58	29	120	153
Ethylene Oxide	450	350	596	624	1,570	2,020
Ammonia	3,600	510	1,020	5,270	6,800	10,400
Acetic Anhydride	920	226	324	450	1,000	1,920
Acetic Acid	462	579	864	2,345	3,788	4,250
Acetaldehyde	600	447	665	2,288	3,400	4,000
Ethyl Alcohol	700	434	587	1,379	2,400	3,100
Formaldehyde (37%)	835	163	234	2,251	2,648	3,483
Methanol	915	256	367	1,345	1,968	2,883
Phthalic Anhydride	216	—	—	—	623	839
Polyvinyl Acetate / Polyvinyl Chloride	381	269	784	566	1,619	2,000
Vinyl Acetate / Vinyl Chloride	438	506	1,038	504	2,048	2,486
Urea	260	41	59	400	500	760
Polyethylene	50	232	338	380	950	1,000
Polystyrene	261	—	—	—	1,104	1,365
GR-S Rubber	800	—	—	—	2,680	3,480
Styrene	539	—	—	—	2,096	2,635
Ethylbenzene	652	—	—	—	2,523	3,175
Phenol	312	—	—	—	938	1,250
Ethylene Dichloride	300	174	406	830	1,410	1,710
Ethyl Chloride	350	—	—	—	900	1,250
Totals	13,619	4,616	8,248	19,402	43,130	56,749

(1) Additional data supplied PETROLEUM PROCESSING by Schooler and Izard.
(2) Estimates by PETROLEUM PROCESSING.

facilities to serve new Dacron plants."

For ethylene glycol outside of these two markets, as well as for most other natural gas petrochemicals, it was not possible to secure information on the geographic expansion in the diverse plants using the primary petrochemicals to process into intermediates and on into finished products. Thus it was necessary to apply the formula of geographic plant expansion corresponding to the geographic distribution of population.

It was recognized that errors would creep into the work through using an oversimplified formula such as relating petrochemical plant expansion program to growth in population. "To minimize the errors," the report states, "it was clearly desirable to begin with those petrochemical products which directly enter into non-petrochemical production. Then we proceed backward in order through tertiary, secondary, and primary petrochemical intermediates, determining for each one its geographic pattern of production and thus the geographic market pattern of the next lower intermediate."

Following this order of end use, some 25 petrochemical intermediates were studied by the MIT and industry authorities for their plant expansion possibilities in the Arkansas-White-Red River basin and in the Gulf Coast area. Supplementary data supplied to PETROLEUM PROCESSING by the authors of the report provided the means for estimating the anticipated expansion for the rest of the U.S. and the total estimated production capacity by 1975 of this group of petrochemicals.

For individual products here are the findings of the study:

Ethylene Glycol: The lion's share of future expansion will tend to be located at or near natural gas sites rather than at the market, especially since the oxidation process seems to be increasingly preferred to the chlorhydrin process. This is to be qualified somewhat if expansion relates to the chlorhydrin process and if in the long run lower power rates are obtainable in the Ohio Valley than at AWR sites.

It is anticipated that, from 1952 to 1975, ethylene glycol production will expand by 550 million lbs. Of this total it may be assumed that antifreeze production will absorb 150 million lbs, Dacron production 350 million and other items 50 million.

In estimating regional expansions to meet requirements for Dacron production, it is believed the South, together with Puerto Rico, is likely to maintain overwhelming dominance in this type of synthetic fiber production. The problem is to determine that part of future Southern expansion in Dacron production which is tributary to the Gulf Coast and AWR regions.

Estimated 1975 Utilization of Petroleum and Natural Gas Hydrocarbons for Conversion to Petrochemicals

	Million lbs
From Methane	14,000
For carbon black manufacture, ammonia, methanol, hydrogen cyanide, methyl chloride, methylene dichloride, carbon tetrachloride, etc.	
From Ethylene	7,000
For ethyl alcohol, polyethylene, acrylonitrile, ethyl chloride, ethylene dichloride, vinyl resins, etc.	
From Propylene	3,560
For isopropyl alcohol, acetone, glycerin, propylene glycol, propylene tetramer and cumene, etc.	
From Butylenes	4,700
For butadiene, secondary and tertiary butyl alcohols.	
From Acetylene (part from carbide)	3,900
For vinyl resins, acetaldehyde, acrylonitrile, acetic acid, acetic anhydride, etc.	
From Benzene	6,650
For styrene, phenol, nylon, aniline, detergents, maleic anhydride.	
From Toluene and Xylenes	2,500
For explosives, vinyl toluene, phthalic anhydride, synthetic fibers, etc.	
Total	28,310

Acrylonitrile: This product feeds into the production of such materials as synthetic fibers, synthetic rubber and plastics. From a rail transport and market location standpoint, the process which starts from ethylene oxide is definitely less favorable than the process which starts from ethane. Any acrylonitrile production which may develop outside natural gas site locations should start with ethane and not with ethylene oxide, provided the acrylonitrile unit is of large scale or provided economies of scale and chlorine advantages in the production of ethylene oxide in the AWR and other regions do not dictate otherwise.

Certain location forces are clear-cut in the production of acrylonitrile. One is the major transport advantage of a natural gas site when water shipment of the product is feasible.

Ethanolamines: Both acrylonitrile and ethylene glycol are estimated to be major users of ethylene oxide in the future. However, ethanolamines, a set of products which serve diverse end uses are also substantial users of ethylene oxide.

Gulf Coast and AWR locations have a major advantage for ethanolamine production. This includes: (1) large transport cost differentials in favor of natural gas sites when water transportation is feasible, (2) modest transport advantages for natural gas sites when rail transport of product is used, and (3) major economies of scale of operations.

Ethylene Oxide: In addition to use in ethylene glycol, acrylonitrile and ethanolamines production, ethylene oxide is consumed in units manufacturing a host of chemical products whose output is small.

The AWR region may produce ethylene oxide for use in the new acrylonitrile and ethanolamines facilities outside the region. This is especially so since shipment of ethylene oxide on the high seas is restricted. AWR natural gas sites can generally out-compete Gulf Coast sites for all major U.S. markets except those in the Gulf Coast area.

Ammonia: In absolute terms this product will experience the greatest expansion of all petrochemicals. There are marked transport advantages for market sites whether shipment is by water or rail. Economies of scale are small and ammonia demands will be largest in major metropolitan regions and their hinterlands. AWR locations should be planned to serve only the needs of this region.

Acetic Anhydride: Currently rayon plants are the largest consumer. It is estimated that by 1975 their consumption will rise by 900 million lb/yr. Use of acetic anhydride in plastics, resins and other products will increase by at least 100 million pounds. Plant loca-

tion factors are (1) transport advantage for natural gas site locations when product shipments can be by water, (2) transport advantage for market site locations when the product is shipped by rail, (3) where major economies of scale can be achieved.

Acetic Acid: Major uses are in the production of acetic anhydride and vinyl acetate. Natural gas locations possess both major scale advantages and substantial advantages in transport when water shipment obtains. It is estimated that at least 25% of the expanded acetic acid requirements in markets outside the Gulf Coast and AWR regions will be met by production in these regions.

Acetaldehyde: Principal uses are for production of acetic acid and acetic anhydride. Geographic linkages between acetaldehyde and its derivatives are strong and it is traditional for companies producing it to use the acetaldehyde in the same plants for further processing into other chemicals. It is judged that the Gulf Coast and AWR region facilities will expand to produce only what they require and exports will be small.

Ethyl Alcohol: Of the future expanded production, at least 60% will be based on ethylene and will consume raw materials from primarily natural gas areas. Pertinent data do not depict clear cut water transport advantage for either market or natural gas site locations. Market sites have a transport advantage under conditions of rail shipment of products. Considering these factors and the economies of scale attainable at natural gas sites, it is judged that at least 25% of U.S. requirements for ethylene based alcohol (excluding requirements for acetaldehyde production in the Gulf Coast and AWR regions) will be supplied from these regions.

Formaldehyde: Large volume uses will be in the production of phenolic resins and plastics and urea resins and plastics. Requirements by 1975 are expected to be around 3.5 billion pounds. Market sites have definite transport advantages under conditions of both rail and water shipment. Economies of scale are rather small in the production of this petrochemical.

Methanol: Future large scale uses are expected in the production of formaldehyde and antifreeze. Expansion in requirements for all uses to 1975 is expected to be close to 2 billion lbs. In view of these problems—(1) lack of any clearcut transport cost differentials under conditions of water shipment, (2) the transport advantages of market points under conditions of rail shipment and (3) the relatively small economies of scale—it is estimated a minimum of 25% of the expansion in requirements for methanol for various uses (excluding the regional requirements for formaldehyde production) will be in the Gulf Coast and AWR regions.

Phthalic Anhydride: Future producduction will be increasingly from ortho-xylene, a refinery derivative. Significant expansion in its output will tend to be linked with expansion in refinery operations.

Polyvinyl Acetate and Polyvinyl Chloride: Treatment of the two as an aggregate is desirable since it is currently difficult to predict which one will dominate the future production of vinyl plastics. Transport cost differentials favor natural gas sites under conditions of water shipment, except in the case of polyvinyl chloride produced from ethane via ethylene dichloride. Should polyvinyl chloride be produced in large volumes in the future, the chlorine or HCL differential due to power will probably favor the Ohio Valley region.

Vinyl Acetate and Vinyl Chloride: The future magnitude of their production cannot be identified separately. Economies of large scale operation are marked. Considering transport cost differentials under conditions of water shipment, vinyl chloride definitely favors market locations, whereas vinyl acetate favors natural gas sites.

Urea: This petrochemical finds its chief uses in production of fertilizers and plastics. No definite transport advantage is shown for either market sites or natural gas sites under conditions of water shipment. There are transport advantages for market sites under conditions of rail shipment. Economies of scale are modest.

Polyethylene: Production is expected to expand rapidly, especially for use in plastics. When bulk water shipment of the finished product is feasible, plant sites in natural gas areas possess a transport cost advantage. These areas also tend to enjoy significant economies of scale, and will likely attract a sizeable fraction of the new polyethylene facilities.

Polystyrene: Chief use will increasingly be in the production of plastics. From both a water and rail transport standpoint it is desirable to locate polystyrene production at the source of the feedstock, styrene. The economies of scale point in the same direction. The forces pulling location points to the source of raw material are further strengthened when consideration is given to the geographic integration of polystyrene and styrene plants based on the ultimate raw materials of ethane and benzene.

GR-S Rubber: It is estimated that at least 70% of the coming plant expansion in facilities will be geographically associated with the sources of the raw materials, butadiene and styrene, and especially with sites where both raw materials are available.

Styrene: Two major future uses will be production of polystyrene and synthetic rubber. Production of styrene is based on one chief raw material, ethylbenzene. Both rail and water transport differentials and economies of scale favor location of facilities at the sources of ethylbenzene.

Ethylbenzene: Production does not show a strong tendency to locate at the source of the raw materials. Economies of scale are marked but the water cost transport differentials in favor of raw material sites are modest. Of the two raw materials for ethylbenzene, ethane and benzene, the latter is primarily a petroleum and coal derivative. Approximately twice as much benzene by weight as ethane is required per unit of ethylene benzene output.

Phenol: The major feedstock will be benzene from refinery operations. Anticipated expansion in production geographically will be influenced by refinery expansions.

Ethylene Dichloride: Principal use is in vinyl chloride but other requirements will be increased by 560 million annual lbs. by 1975. Advantages of natural gas sites for serving markets outside the Gulf Coast and AWR region are: (1) scale advantage from larger plants and (2) power cost advantage, particularly in the production of chlorine, when the natural gas sites enjoy a fuel advantage, as they will continue to do in most sections.

Ethyl Chloride: Chief uses are in manufacture of tetraethyl lead and ethyl cellulose. Annual requirements by 1975 will be 1.25 billion lbs. Foreseen is a marked concentration of TEL plants in the Gulf Coast and to a lesser extent in other areas where petroleum refining is expanding.

Methyl Chloride: A relatively small tonnage petrochemical with diverse end uses. Since production will not be of sufficient volume to justify water shipment, rail transport cost differentials are relevent. Large economies of scale are indicated.

Acknowledgment

The Editors of PETROLEUM PROCESSING acknowledge the aid given in the preparation of this article by Eugene W. Schooler, of Massachusetts Institute of Technology, in supplying data supplemental to that given in the report, "Location Factors in the Petrochemical Industry."

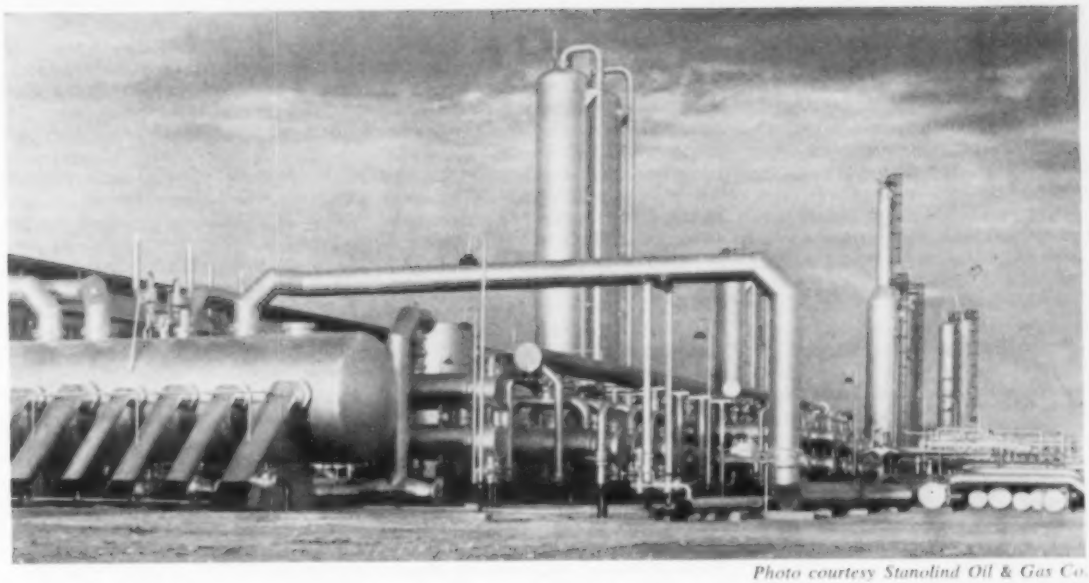


Photo courtesy Stanolind Oil & Gas Co.

FEW OPERATORS AND REMOTE LOCATION in a typical installation mean . . .

Today You Need Good Design for . . .

Electricity in a Gasoline Plant

By E. A. NOSER
Hudson Engineering Corp.*

AT first glance, a present-day natural gasoline plant appears to be a relatively large operation employing many operators. Actually, however, a plant which may cost several million dollars to build will have but a few—perhaps three or four men on duty per shift.

Furthermore, it is frequently located remotely from cities and towns, and does not have maintenance personnel constantly at hand who are capable of analyzing and repairing electrical facilities. Processing is continuous. Design of all component parts of the system must be analyzed carefully to assure continuous, trouble-free operation.

Six essentials to good electrical design in a natural gasoline plant:

1—The electrical power source must be extremely reliable.

2—All service units vital to continuous operation must have spare units which are ready to start without delay.

3—Feeders to all vital areas must be in groups of two or more.

4—All design must be as simple as possible so that maintenance will be minimum and will be of such a nature that any electrician may be called to make adjustments and repairs.

5—Alarm circuits should be provided to alert the area operator and direct him to the source of trouble without delay.

6—Shutdown circuits should be provided to shut down vital equipment when abnormal conditions make this imperative.

Power Source

Power may be provided by an electric utility or by plant operated generators. A power source outside the plant is satisfactory for plants that have pumps operated by steam or gas engine drivers in all services necessary to continuous operation. Many fine plants of this type have been built in the past and will be in the future using electrical power primarily for lighting and alarm services.

The modern trend in gasoline plant design is toward electrically driven pumps and auxiliaries, and with this trend has come the plant operated electric power generators.

A typical plant might have a connected load of 900 KVA with an expected power factor of 80% or better. Generators for this plant would usually be driven by natural gas, four cycle engines. Three or four units would be purchased with one a spare. The selection of gas engine drivers for the generators would be warranted by these points:

1—Available fuel at low cost

2—Good efficiency

3—Low maintenance

4—Long life expectancy

The generators might be 480-volt, 3-phase, 60-cycle, 400-rpm machines with amortisseur windings and split rotors, with belt-driven shunt-wound exciters, pedestal-mounted, and operating at 1750 rpm.

Switchgear

Switchgear required for a plant having no generators can be quite simple. Generally, a power distribution panel is sufficient. It should have a voltmeter, an ammeter and transfer switches for these instruments.

Our typical plant with 900-KVA connected load will require a free-standing switchgear with three or four generator panels, a synchronizing panel, a bus transition panel, and sev-

* Mr. Noser is an electrical engineer with Hudson Engineering Corp., Houston, Texas. This article is based on his paper, "Electrical Design in a Modern Gasoline Plant," presented at the Petroleum Industry Electrical Conference, American Institute of Electrical Engineers, Houston, Sept. 13, 1955.

eral power distribution panels. The switchgear would be 90 in. high and 48 or 54 in. deep. The 54-in. depth is better as it allows more room for installation of cables without interference with the bus work in the switchgear.

Each generator panel should contain the following equipment:

1—AC ammeter with transfer switch
2—AC wattmeter
3—DC ammeter
4—voltage regulator
5—voltmeter transfer switch for an AC voltmeter located on the synchronizing panel
6—governor motor switch
7—synchronizing switch
8—exciter field rheostat
9—air circuit breaker, three-pole, three-coil, 600-volt, with instantaneous and time-delay overload trips.

The following additions, though not entirely necessary, are well worth the slight additional cost to the switchgear:

1—A time-delay reverse power relay
2—An elapsed time meter
3—Electrical operation and a red and a green pilot light for the generator circuit breaker
4—An automatic synchronizing position for the synchronizing switch.

Only one handle will be provided for all the voltmeter transfer switches and only one handle for the synchronizing switches. These handles will be removable in the "off" position only and must not be interchangeable.

The upper section of the generator panel should be hinged to permit access to the small wiring and the instrument fuses. The lower section should contain the generator circuit breaker which should be of drawout construction.

The synchronizing panel is usually located at the generator control end of the switchgear. It is approximately 18 in. wide, 8 in. deep and 24 in. high. It is hinged to the generator panel so it may be swung out in order that the meters thereon may be easily seen from any generator panel. The synchronizing panel should contain:

1—An AC bus voltmeter
2—An AC voltmeter connected to the voltmeter switches on the generator panels
3—A synchroscope
4—A bus frequency meter

Also desirable on the synchronizing panel are a simple automatic synchronizer and two synchronizing lamps.

The front portion of the bus transition panel may be divided into three equal horizontal sections 12 in. deep. In the upper section it is convenient to mount a totalizing kilowatt-hour meter, a power factor meter, and three ground detector voltmeters, Y-connected with a normally closed push-button to ground. The lower two sections may contain the lighting distribution circuit breakers. Panelboard construction will permit as many as eight, front removable, three-pole, 100-amp., 250-volt circuit breakers to be installed in each of these sections.

The back section of the transition panel provides adequate space for the bus transition between the generator panels and the power distribution panels of the switchgear. Current and potential transformers required for the totalizing kilowatt-hour meter can be installed as well.

Each power distribution panel may contain six or more front removable, bakelite frame, three-pole, 600-volt circuit breakers with separable studs. These circuit breakers may be of 225-amp., 400-amp., or 600-amp. frame size, with 15,000 or 25,000 rms ampere interrupting capacity. The buses at each end of the switchgear should be punched to permit the addition of future generator or distribution panels. The buses in the switchgear should be sized for future plant growth.

Lighting Distribution

The principal parts of a gasoline plant are generally located in an area sufficiently small to make lighting distribution at 120/208 Y volts quite practical. One set of three 480/120 volt transformers may be located in or adjacent to the generator building, with the transformer low voltage leads connected to the lighting distribution section in the switchgear described above. This system of lighting distribution makes it unnecessary to locate transformers in the hazardous areas.

Feeders

Gasoline plants seldom are built in their final form. In power circuits this means that additional pumps or cooling equipment might be added without notice. This practice has caused many gasoline plant designers to veer away from a centralized motor control setup to a system employing two or more power feeders to each plant area. Motor controllers may be grouped on racks near the motors served. The addition of motor driven equipment at any time can be handled easily with no long feeders required. Feeder circuits can be installed overhead in all areas where supports are provided for overhead pipe. These conduits can be attached to the underside of the overhead supports with U-bolts. Conduits installed overhead in hazardous areas should have breathers installed at the highest points and drains installed above all seals in risers to these conduits.

Feeders are installed underground to areas where pipe supports are not available. These feeders may be in rigid steel conduit or in transite or fiber conduit embedded in concrete. They should be buried to a depth of four feet below grade to prevent damage to them during future excavation.

One lighting feeder, 120/208 Y, 4-wire, should be installed from the lighting distribution panel in the generator building to each plant area. There it may terminate in one or several lighting panels, with main circuit breakers when required by the code.

Plant Areas

The gasoline plant may be divided into the following six general areas:

1—generator building.
2—boiler and rich oil heater.
3—compressor building and scrubber.
4—process.
5—storage and loading pump.
6—office, warehouse, and shops.

The generator building will contain the generators and switchgear, and, usually, the engine starting air compressors and instrument air compressors. The adjacent area will contain the air supply tanks, instrument air dehydrator, and the generator engine jacket water coolers. NEMA-I motor controllers are used for this equipment and are located in the generator building.

It is common practice to locate the generator control switchgear parallel to the roof ridge of the building and adjacent to the generators. Since the generators in a gasoline plant are relatively small, in the interest of a more economical building design, the switchgear can be located across one end of the building at right angles with the roof ridge.

This arrangement decreases the width of the building considerably which, of course, reduces its cost. A trench can be constructed under the switchgear entirely across the building width to facilitate the installation of feeder and generator cables, both immediate and future. Floor plate covers all the trench area not under the switchgear. Future generator panels and feeder panels are added by removing floor plate. Conduits should be stubbed into the switchgear pit for these future additions.

Air compressors, plant lighting transformers, and instrument air dehydrators can be located behind the

switchgear adjacent to the end wall of the building.

Alarm circuits are often provided for high jacket water temperature and low lubricating oil pressure for the generator engines.

The boiler and rich oil heater area contains those units, plus deaerator heater, boiler feed pumps, boiler draft fans, and water treating equipment. Two power feeders are brought to this area with one set of equipment on one feeder and the spare equipment on the other feeder. The control equipment for the boilers and heaters is pneumatic.

Electrical alarms are often provided for boiler draft fan failure, deaerator heater water level, and rich oil heater high stack temperature. In some plants the rich oil heater high stack temperature device will shut off the gas supply to the heater.

Compressor building and scrubber area contains those units, plus the gas coolers, and the compressor jacket water pumps and coolers. Usually, no motor driven equipment is located in the compressor building.

In more recent years jacket water and compressor gas are cooled in air cooled heat exchangers. These employ induced draft fans driven by motors of 5 to 25 hp. capacity each. Quite often these fan motors are two-speed units. Some air cooled heat exchangers are now produced that have variable pitch fans that are controlled by the temperature of the medium in the tubes.

Power is required for these fans and for the jacket water pumps. Multiple power feeders are provided to assure continuous operation of the jacket water pumps and allow half of the fans to operate in the event of a feeder failure.

A jacket water low pressure alarm is generally provided with a solenoid operated air horn located inside and outside the compressor building. An alarm system should be installed to indicate high liquid level in the scrubbers with a shutdown system which will stop the compressor engines before liquid can flow from the scrubbers into the compressor cylinders.

Two level switches are located, one above the other, on each scrubber. The lower switch operates a light and a common alarm horn. The upper switch operates the engine shutdown device. Sometimes these alarm lights are located on a panel in the compressor building but it is preferrable to locate an alarm light above each scrubber with a light test, horn test, and horn silencing button on the scrubber near the base.

The process area is the heart of the gasoline plant. It contains the processing vessels, the cooling tower, numerous heat exchangers, liquid accumulators, and many pumps.

Electrical power feeder conduits can be located overhead attached to the underside of the horizontal pipe supports. The motor starters are arranged in groups and mounted on structural steel racks between the pipe supports.

A spare pump is provided for each operating pump; hence, it is common practice to run two feeders to each starter rack to insure continuous operation as described previously. The starter racks are constructed in such a manner that additional starters may be added to either end of the rack. Start-stop stations are located adjacent to the pumps.

Alarms in the process area, when required, are used primarily for liquid level conditions.

The storage and loading pump area contains the propane, butane, gasoline, kerosene, mineral seal oil, and other storage tanks. Nearby are the loading pumps used to transfer the products from these tanks to the truck loading racks and the railroad car loading rack. These racks may be at considerable distances from the storage and loading pump area.

Multiple feeders are run underground from the generator building or from the nearest pipe support to the loading pump area. Here they feed motor starters grouped on racks serving the loading pumps.

If the truck loading rack or car loading rack is relatively close, it is a great convenience to the loading personnel to provide start-stop stations with pilot lights at the loading racks. When the racks are too far away to make this feasible, pressure switches or flow operated devices located near the loading pumps are used.

Plant office, warehouse and shops are generally grouped 150 ft. or more away from the plant area. A small laboratory for product analyses and control is often incorporated as part of the plant office. The warehouse and shops are combined as one building in many plants. One power and one lighting feeder to this area are all that are required to serve these buildings since they are not vital to plant operation.

Hazardous and non-hazardous areas: The gasoline plant may be divided into hazardous and non-hazardous areas in accordance with the rules of the National Electrical Code. The hazardous areas are: (1) the process area, (2) the compressor and scrubber area, and (3) the storage and loading pump area.

The non-hazardous areas are: (1) the boiler and heater area, (2) the generator building area, and (3) the office, warehouse and shops area.

Plant Lighting

Plant lighting in a gasoline plant differs little from lighting in any other plant. It is only necessary to bear in mind that the plant operators must carry on their work efficiently all through the night. A good lighting design will provide light for all equipment, essential pressure gauges, liquid level gauges, and control panels.

Industrial and commercial fixtures are generally specified for the office, warehouse and shops. Vaportight lights and fittings are used in the boiler and rich oil heater area, and the generator area. Vaportight, or preferably, explosion-proof lights and fittings are used in the process area, compressor and scrubber area, and the loading pump area.

Vaportight floodlights, singly or in groups of two, three or four, mounted 30 ft. high on 6 in. pipe standards, serve nicely to provide general yard lighting. When used, these floodlight poles should be located 50 ft. away from hazardous equipment and vessels.

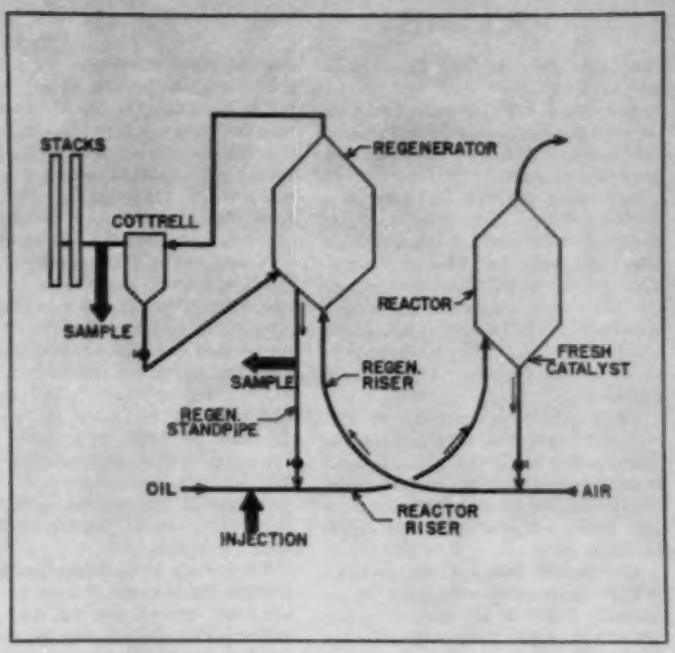
The writer has found it quite handy to install flanged explosion-proof junction boxes (the type used as the base fitting for explosion-proof flange mounted and bracket mounted lighting fixtures) on all pipe supports in the lighting conduit runs in the process area. This practice makes it quite simple to add a light at any time to increase the illumination in a dark area or to light a gage or level control which may be added after operation of the plant has started.

Shutdown Systems

Every effort is made to insure safe operation of the modern gasoline plant as it must be remembered that exceedingly combustible liquids and gases are handled continuously. If a fire or explosion should occur it is of greatest importance that the equipment can be shut down quickly to limit the scope of the damage.

Shutdown stations are located at several places in the plant area. A shutdown station may consist of several quick operating switches which can individually shut off fuel gas to the boilers and heaters, shut down the compressors, shut off gas entering the plant, and shut down the generators.

A plant telephone system is often installed in a gasoline plant. Usually it contains less than ten telephones. The simplest and best type is the sound powered telephone with a signalling system run in a separate conduit.



SETTING UP A TRACER SYSTEM IS EASY (right)—arrows show locations of injection and sampling points in commercial Fluid cracking unit

INJECTION OF TAGGED CATALYST (far right) into hot oil line is handled by this relatively simple feeding device

Better Catalyst Loss Studies

How the radioactive cobalt tracer technique has been applied successfully to a Fluid unit

By A. J. KINSELLA, Jr.
and
J. J. MITCHELL
The Texas Co.

THE physical behavior of catalyst during actual processing in a commercial Fluid catalytic cracking unit has been studied successfully by means of radioactive tracers.

In an experimental program carried out by The Texas Co., fresh fluid catalyst was tagged with radioactive cobalt and charged to the process unit by an especially designed injection technique. During this study the Fluid unit operated with high stack losses, and untagged make-up catalyst was added continually as an oil slurry to the reactor.

One valuable result of the work was development of a possible explanation for the observed fact that catalytic activity decreases in a Fluid unit under conditions of prolonged high stack losses.

Apparently, older and less active material is preferentially retained within the unit because of its greater resistance to attrition, while fresher and less attrition-resistant catalyst is preferentially lost. In the studies the tagged and new catalyst was preferentially lost during the first 80 days of operation. After that time it was preferentially retained during the next 59 days.

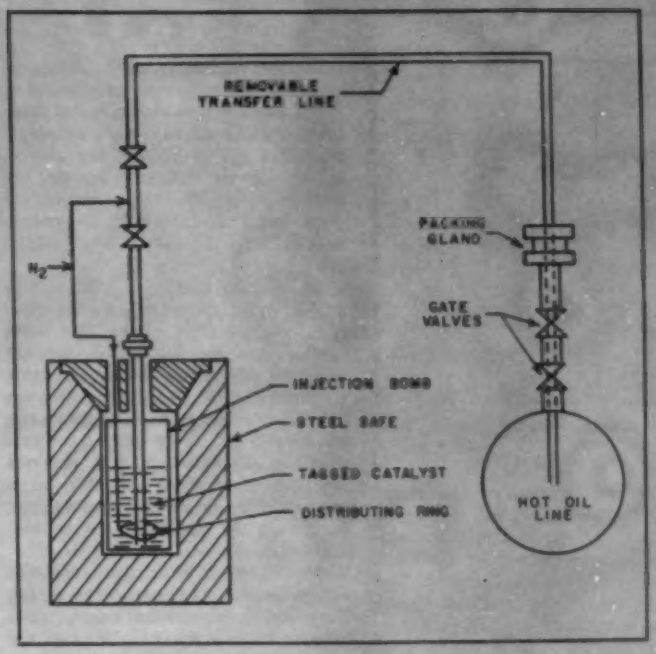
Other results from the study were:

- There was no large immediate loss of the tagged catalyst. Average stack loss of fresh (tagged) catalyst was about 1.9% per day during the first 22 hrs.
- The tagged catalyst mixed completely with all available catalyst in the unit in about 1 to 2 hrs.
- Not all of the catalyst in the Fluid catalytic cracking unit was available for immediate mixing. An estimated 2% was held up at various places in the unit, and was slowly mixed in over a period of about 24 hrs.

Experimental Work

Preparation of Tagged Catalyst: The fluid cracking catalyst used in this study was taken from plant receipts so that it would be representative of that in the test unit. It was a synthetic, silica-alumina material in the form of microspheres ranging from less than one micron in diameter to more than 80 microns. Average particle size was about 40 microns.

Cobalt-60 was selected as the tracer



for this work. This isotope, formed by neutron irradiation of ordinary cobalt in the pile at Oak Ridge, was allocated by the Isotopes Division of the Atomic Energy Commission and supplied by the Oak Ridge National Laboratory as an aqueous solution of the nitrate. 50 millicuries were used in the study.

In preparing the tagged catalyst, the radioactive cobalt was diluted and then mixed with about 350 grams of fluid catalyst. After being thoroughly mixed, the tagged catalyst was calcined to drive off the excess water and decompose the nitrate. This left the Co-60 on the catalyst as the relatively insoluble oxide.

On the basis of a supplementary study, it is believed that this method of preparation distributed the Co-60 evenly throughout the test batch of tagged catalyst and, more importantly, distributed the radioactivity *evenly* throughout the pores and over every available surface of the individual catalyst particles.

Data substantiating this are shown in Table 1, which presents the specific activities of products from the accelerated attrition of a fines-free catalyst.

It is apparent that the products of attrition have the same radioactive concentration as the original charge catalyst. Since the attrition process consists primarily of the erosion of fine fragments from the surfaces of the catalyst particles, anything other than an even distribution of radioactivity throughout the individual catalyst particles would have resulted in a preferential concentration of radioactivity in one of the products of attrition. The data prove that this was not the case.

Injection and Sampling: A simplified flow diagram of the Fluid catalytic cracking unit used during this study is shown on opposite page. The unit consists of a reactor and a regenerator connected by transfer lines, together with associated equipment. Both the reactor and regenerator contain fluidized beds of catalyst, and catalyst constantly circulates between the vessels as shown by the small arrows. Fresh catalyst is normally added as a slurry with oil to the reactor. Catalyst fines escape from the system through the flue gas stacks. Excess spent or equilibrium catalyst is withdrawn as necessary from the regenerator standpipes.

The tagged catalyst was injected dry into the charge oil line immediately ahead of the point at which the charge oil enters the reactor riser that returns regenerated catalyst to the reactor.

Variations in radioactive content of the circulating catalyst and the catalyst lost through the stacks were followed by sampling appropriate catalyst streams and counting the samples for gamma activity. (See flow diagram.)

Unit catalyst was sampled at a point about halfway up the regenerator standpipes, removing spot samples through a draw-off valve. Stack catalyst—the fine material carried out of the unit with the flue gas—was sampled at the Cottrell breeching, immediately ahead of the flue gas stacks. Continuous samples were caught by passing a slipstream of the flue gas through a filtering arrangement to remove entrained material.

The injection system is shown schematically in the second drawing. Prior to injection, the tagged catalyst was contained in a stainless steel injection-bomb enclosed in a steel safe used as a radiation barrier. The injection bomb was connected indirectly to

Why Was Radioactive Cobalt Used?

Accurate knowledge of the behavior of catalyst in a Fluid catalytic cracking unit is important. Unlike the beaded catalyst in other cracking units, Fluid cracking catalyst is lost to the atmosphere and becomes an important factor in economic operation of such a unit.

Until this study was undertaken by The Texas Co., there was no proved procedure for studying the mixing and the loss of fresh catalyst in commercial Fluid catalytic cracking units. Radioactive isotopes made this study possible. The availability of radiocobalt enabled the authors to distinguish fresh catalyst from any other in the system, and quantitatively measure mixing behavior and stack losses.

To accomplish this it was necessary to develop techniques and equipment for impregnating Fluid catalyst with radioactivity, injecting it into the test unit, and sampling and analyzing the results. This is the story of *how* radiocobalt made this study possible.

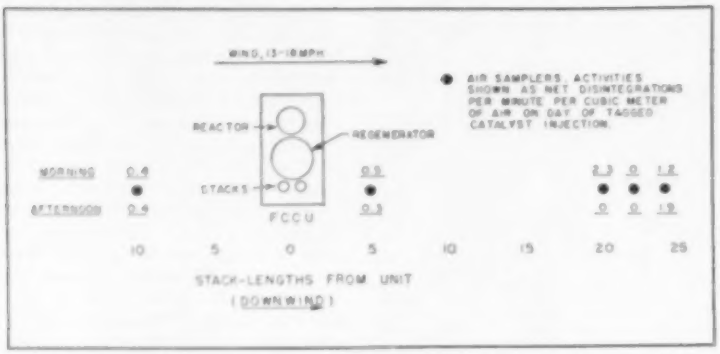


FIG. 1—TO CHECK AIR POLLUTION POSSIBILITIES, air samples were taken at the locations shown in the above plot plan

the hot-oil charge line by a removable transfer line, which passed through a packing gland and two steel gate valves into the center of the hot oil stream. The transfer line was flushed continuously with nitrogen to prevent oil vapors from entering it. During injection, nitrogen was directed into the injection-bomb through an enclosed distributing ring, fluidizing the tagged catalyst and forcing it through the transfer line into the hot oil stream and thence to the reactor system. The transfer of the tagged catalyst from the bomb to the hot oil stream was practically instantaneous, as indicated by survey meters directed at the catalyst container and the transfer line.

Sample Counting and Analysis: The catalyst samples taken during this study were counted for gamma activity with special, high-sensitivity counters developed by The Texas Co.

Results were expressed as specific activity in counts per minute per gram of catalyst (c/m/g). The radioactive level of any sample was a direct measure of the amount of tagged catalyst in that sample. So, it was necessary only to compare the specific activity of a given sample with the specific activity of a catalyst standard (containing a known amount of radioactivity) in order to obtain the concentration of tagged catalyst in the sample.

The use of standards containing the same amount and type of catalyst as the samples eliminated any effects of self-absorption in the counting procedure; thus, no corrections for self-absorption were made to any of the data.

Counting data for the unit catalyst samples are considered very good; probable errors range from ±0.7% for high-count samples to ±3.4% for low-count samples. Counting data for stack samples are not considered very good, however. The samples were limited to 5 grams or less by the sampling procedure. As a result, probable counting errors on the stack catalyst range from ±9% on high-count samples to as much as ±67% on low-count samples. Counting accuracy on the stack samples could have been improved by shielding the counter and this should be done in any future similar study.

Experimental Results

Initial Loss of Tagged Catalyst: One of the first answers sought in this study related to the initial loss of fresh catalyst, following its addition to a Fluid catalytic cracking unit. At one time it had been estimated that as much as 25% of fresh catalyst added to a unit, by way of the regenerator, might be lost immediately through the stacks, with less being lost when the fresh catalyst was added to the reactor (as in the present study).

Since the stack catalyst contains both equilibrium and fresh catalyst fines, it was expected that any abnormal loss of the tagged fresh catalyst would immediately show up as a high level of activity in the stack catalyst samples. Table 2 shows the *calculated* level of activity which might be expected at several abnormal tagged-catalyst loss rates compared with the calculated level expected for a normal loss rate, i.e., same as the equilibrium catalyst loss rate.

For example, the forementioned immediate loss of 25% of the fresh (tagged) catalyst would result in the initial stack catalyst sample having a specific activity of about 21,000 c/m/g, as compared to a normal-loss level of 11.4 c/m/g.

The actual specific-activities of the stack catalyst for the first 22 hrs. of the tracer study are shown in Table 3. Each of the values shown is the composite specific activity of a continuous sample caught during the time interval shown. It is apparent despite the scatter of the data that none of the stack samples contained an exceptionally large amount of the tagged catalyst.

The highest activity in Table 3, i.e., 27.4 c/m/g, represents a tagged catalyst loss rate only about 2½ times greater than the equilibrium catalyst loss rate. Moreover, the average specific activity of 16.5 c/m/g for the first 22 hrs. represents a tagged catalyst loss of only 1.9% per day. While this is much higher than the normal equilibrium catalyst loss rate, it is much lower than might have been expected on the basis of previous estimates.

Air Pollution: When this study was conceived, one of the problems facing the investigators was that of the radioactivity leaving the unit through the stacks. It was easy to visualize about 10 or 15 millicuries of Co-60 leaving the unit as a dense cloud of catalyst particles and then raining down in the immediate area.

In order to determine the presence of any such radioactive fall-out, as well as to furnish legal proof of the presence or absence of air-borne radioactivity at the time of the tracer study, a simultaneous air pollution study* was conducted for several days before and during the test period. A number of air samplers were secured on loan from the AEC, and these samplers were operated at various distances upwind and downwind from the Fluid unit stacks. Air-borne dust caught by these samplers was counted for beta activity by the Health and Safety Laboratory of the AEC, New York Operations Office.

Fig. 1 shows an aerial sketch indicating the location of the samplers and the beta activities at those locations during the morning and afternoon of the first day of the tracer study. The activities are expressed as net disintegrations per minute per cubic meter of air (d/m/m³).

Only one day's results are shown; however, data secured on several other days agree with that depicted in Fig. 1. The activity of the air-borne dust downwind of the Fluid unit stacks was very low, averaging about 0.8 d/m/m³, as compared with about 0.4 d/m/m³ upwind.

This indicates that there was no ex-

"Soyez les Bienvenus à Montréal au Mois de Mai!"

* This study was carried out under the direction of A. E. Dooley, Health Division, Industrial and Public Relations Dept., The Texas Co.

cessive fall-out of radioactivity at any of the sampler locations and, by inference, little fall-out in any area. Actually, at the loss rate shown previously, about one millicurie of cobalt-60 left the unit on air-borne catalyst during the first day. This small amount of activity apparently was dispersed safely over a very wide area.

Mixing: In order to determine the mixing pattern of the tagged catalyst with the equilibrium contents of the Fluid unit, spot samples of unit catalyst were taken at 15-minute intervals for 8 hrs., and at hourly intervals thereafter for 15 hrs. The results from this rapid sampling are recorded in Table 4 and plotted in Fig. 2, showing the variation in the specific activity (c/m/g) which occurred in the unit during the first 23 hrs. after the tagged catalyst was injected.

For comparison, the expected level of activity for the same period is shown as a broken line. This expected level of activity was calculated with the assumption that all of the added tracer was homogeneously mixed with all of the equilibrium catalyst in the unit; the line has been sloped from an initial value of 11.4 c/m/g to a 24-hr. value of 11.2 c/m/g to account for the previously determined stack loss of 1.9% per day.

Several things are immediately apparent in Fig. 2. First, the rapidity with which the experimental points attain a state of equilibrium shows that the tagged catalyst mixed with the available unit catalyst in very short order. Most of the mixing had occurred within an hour after the tagged catalyst was added.

The second observation apparent in Fig. 2 seems to constitute a discrepancy. The specific activity of the unit catalyst attains an equilibrium value which is consistently higher than the calculated level during the first 23 hrs.

For example, after two hours of mixing, the experimental data indicate an activity of 11.9 c/m/g as compared with an expected value of 11.4 c/m/g; this is about 4.6% higher than calculated. At first glance, it might be assumed that the difference in activity levels is due entirely to an error in the method of calculating the expected value; i.e., that more radioactivity was added than the amount used to calculate the expected level, or that less catalyst was present in the unit than reported.

However, it should be noted that whereas the stack loss (the only means by which the radioactivity could have left the unit) for the 23-hr. period was about 1.9%, the mixing data show a decrease of about 3.5% for the same period. Also, the long-time data (which is discussed below) show that daily loss of activity from the unit decreased sharply from 3.5% the first day to about 1.6% the next day, and averaged about 1.5% during the next ten days.

Thus, the data indicate that at least part of the difference between the calculated and experimental levels of activity represents a true situation in which not all of the unit equilibrium catalyst was available for immediate mixing.

It is felt that the 1.6% difference between the indicated unit loss and the stack loss (3.5%-1.9%) represents a small amount of semi-dormant catalyst that is held up in various parts of

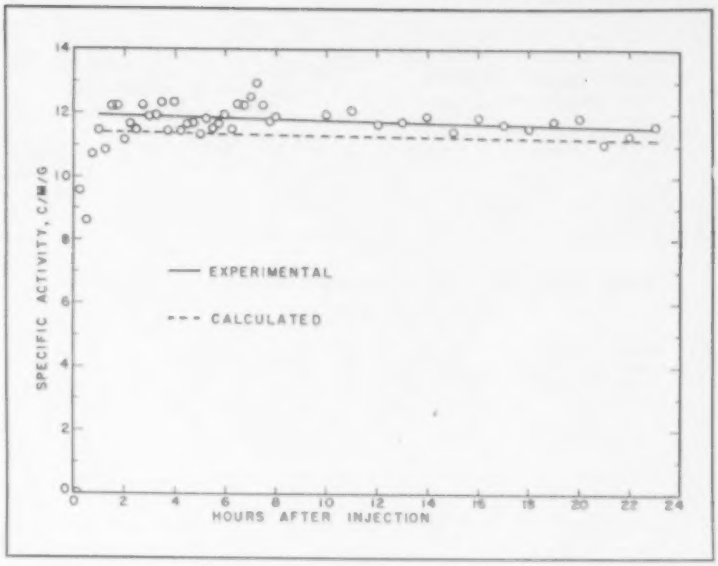


FIG. 2—Radioactivity of unit catalyst during mixing period (see Table 4)

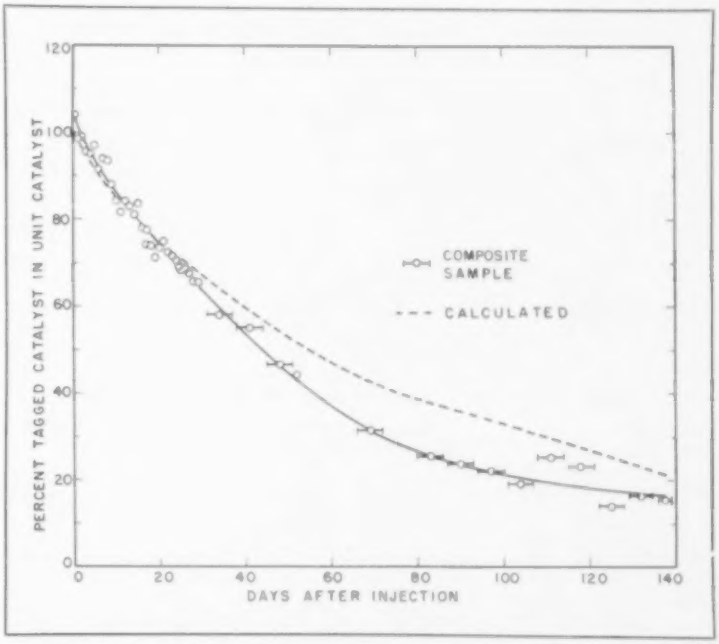


FIG. 3—Radioactivity of unit catalyst during entire test period (see Table 5)

Table 1—Radioactivities of Various Tagged Catalyst Fractions

(Specific activity in counts/min/gm of sample)

Sample	c/m/g
(1) Fines-free catalyst charge	1049
(2) Coarse product from attrition of (1)	1050
(3) Fine product from attrition of (1)	1047

Table 2—Calculated Activity of Initial Stack Sample at Several Assumed Loss Rates of Tagged Catalyst

Assumed Loss Rate	c/m/g
25% lost immediately	21,200
25% per hr.	5,310
25% per day	221
Same as equilibrium catalyst loss rate	11.4

Table 3—Activity of Stack Catalyst during First 22 hours

(Catalyst Injected at 11:00 a.m.)

Time during which sample was collected	c/m/g	Time during which sample was collected	c/m/g
11:00-11:15 a.m.	5.8	10:30-11:30	19
11:15-11:30	27	11:30-12:00 a.m.	15
11:35-12:30 p.m.	22	12:30-1:30	17
12:30-1:30	18	1:30-2:30	9.4
1:30-2:30	19	2:30-3:30	16
2:30-3:30	21	3:30-4:30	18
3:30-4:30	13	4:30-5:30	26
4:30-5:30	17	5:30-6:30	6.9
5:30-6:30	—	6:30-7:30	23
6:30-7:30	12	7:30-8:30	23
7:30-8:30	10	8:30-9:30	19
8:30-9:30	13	**Average**	16.5
9:30-10:30	8.9		

Table 4—Activity of Unit Catalyst during First 23 hours

(Catalyst Injected at 11:00 a.m.)

Time of Sampling	c/m/g	Time of Sampling	c/m/g	Time of Sampling	c/m/g	Time of Sampling	c/m/g
11:00 a.m.	0	5:00 p.m.	12.0	2:15	11.9	12:00	11.8
11:15	9.6	5:15	11.5	2:30	12.3	1:00 a.m.	11.9
11:30	8.6	5:30	12.3	2:45	11.4	2:00	11.4
11:45	10.7	5:45	12.3	3:00	12.3	3.00	11.9
12:00	11.4	6:00	12.5	3:15	11.4	4:00	11.7
12:15 p.m.	10.8	6:15	12.9	3:30	11.6	5:00	11.5
12:30	12.2	6:30	12.3	3:45	11.7	6:00	11.8
12:45	12.2	6:45	11.7	4:00	11.3	7:00	11.9
1:00	11.2	7:00	11.9	4:15	11.8	8:00	11.1
1:15	11.7	8:00	11.3	4:30	11.5	9:00	11.3
1:30	11.5	9:00	12.0	4:45	11.7	10:00	11.6
1:45	12.2	10:00	12.1			**Average**	11.65
2:00	11.9	11:00	11.7				

Table 5—Activity of Unit Catalyst during Test Period

Days After Start of Test	c/m/g	Catalyst Remaining In Unit	Days After Start of Test	c/m/g	Catalyst Remaining In Unit
0*	11.65	102.9	22	8.26	72.4
1	11.34	99.5	23	8.15	71.5
2	11.29	99.0	24	8.02	70.3
3	10.90	95.6	25	7.78	68.2
4	10.87	95.4	26	7.82	68.7
5	11.06	97.0	27	7.70	67.5
6	10.43	91.4	28	7.50	65.8
7	10.70	93.8	29	7.48	65.6
8	10.69	93.7	31-37	6.62	58.0
9	10.06	88.1	38-44	6.26	54.8
10	9.58	83.9	45-51	5.33	46.7
11	9.33	81.7	52	5.13	45.2
12	9.60	84.2	66-72	3.60	31.6
13	9.46	83.0	80-86	2.94	25.8
14	9.19	80.7	87-93	2.70	23.6
15	9.52	83.5	94-100	2.56	22.5
16	8.92	78.1	101-107	2.17	19.1
17	8.67	75.9	108-114	2.91	25.5
18	8.43	73.9	115-121	2.66	23.3
19	8.13	71.2	122-128	1.58	13.8
20	8.34	73.3	128	2.82	24.7
21	8.55	75.0	129-135	1.97	17.2
*Average value for first 22 hr.			136-139	1.81	15.8

the unit and does not mix in at first, thus accounting for the excess activity. Furthermore, it appears that this small amount of semi-dormant catalyst slowly mixes in over a period of about 24 hours, as shown by the fact that daily activity loss from the unit levels off at about 1.5% after 24 hrs.

It must be admitted, however, that the idea of semi-dormant catalyst can only account for 1.6% of the 4.6% difference in activity levels shown by Fig. 2. The remaining 3% excess is probably due to an error in one or both of the values used to calculate the expected level of activity in the unit. Since this affects only the general level of the data and does not affect rates and trends as discussed in this paper, no further adjustments to the data were made.

Long-Time Loss of Tagged Catalyst: As previously discussed, when fresh make-up catalyst is added to a Fluid unit, there is an immediate loss through the stacks. After this, for an indeterminate period of time, the one-time-fresh catalyst continues to be lost through the stacks at a decreasing rate together with older and newer catalyst from the equilibrium contents of the unit. Furthermore, any catalyst withdrawn from the unit contains an aliquot fraction of the one-time-fresh catalyst remaining in the unit. The one-time-fresh catalyst remaining in the unit is increasingly diluted each time make-up catalyst is added.

Theoretically, unless the catalyst contents of a Fluid unit are completely removed and dumped, any equilibrium catalyst in the unit should contain a fraction of every batch of make-up catalyst ever added to the unit.

Therefore, in setting up this study it was expected that the measured radioactive content of the equilibrium catalyst in the test unit would rise to a maximum when the tagged catalyst was mixed into the equilibrium catalyst, and would then decrease asymptotically towards zero over an extended period of time.

In order to follow the extended decrease of tagged catalyst in the unit, spot samples of unit catalyst were taken daily for about 29 days and counted for gamma activity. Thereafter, for about the next three months, routine control samples from the unit were counted so as to determine the tagged-catalyst concentration remaining. The test was terminated by the annual test and inspection of the unit, 139 days after its inception.

The results of this long term sampling are recorded in Table 5 and plotted in Fig. 3. In order to provide a clearer understanding of the tagged catalyst behavior, sample activities

have been expressed as a percentage of the calculated initial unit activity (11.4 c/m/g). Thus, the solid curve in Fig. 3 shows the percentage of tagged catalyst remaining in the unit at any time during the study. It is apparent from the plot of the experimental data that the decrease of tagged catalyst in the unit did not follow the expected course, especially during the latter part of the test.

It may be well to point out here that no adjustment was necessary to correct these data for the normal decay of tracer activity. The use of a standard prepared from the same batch of cobalt-60 as that which was injected makes this correction unnecessary.

As a means of comparison, the broken line in Fig. 3 shows the calculated decrease in activity expected during the test period. This line was calculated from plant records of catalyst inventories, loadings, and losses for the test unit during the period covered by this study. In calculating this line, the simplifying assumption was made that all catalyst leaving the unit, whether in stack losses or withdrawals, had the same activity as the catalyst remaining in the unit.

Such an assumption was known to be true only of the catalyst withdrawals; previously discussed data showed that the concentration of tagged catalyst in the stack samples was higher than in the unit catalyst samples during the first 22 hrs.

However, such an assumption did provide a simple method of telling whether this preferential loss of tagged catalyst to the stacks continued and, if so, for how long, since any deviation of the experimental curve from the calculated could be attributed primarily to the tagged-catalyst content of the stack catalyst.

The amount of tagged catalyst remaining in the unit decreased more rapidly than calculated during the first 80 days of the study, and less rapidly thereafter, as shown in Fig. 3. This indicates that tagged catalyst continued to be preferentially lost with the stack catalyst for about 80 days, but that after that time it was preferentially retained in the unit.

First consider the initial 80 days of rapid loss. Since the stack loss from a Fluid unit is primarily very fine catalyst formed by attrition, the data plotted in Fig. 3 show that the attrition rate of the fresh tagged catalyst was initially higher than that of the unit catalyst, and that the attrition rate gradually decreased until it equalled that of the unit catalyst after a period of about 80 days.

Actually, this is exactly what one would expect. Laboratory accelerated attrition tests have shown that used catalyst is much more attrition resistant than the same catalyst when fresh. Therefore, one would expect the tagged catalyst to become more attrition resistant as it aged in the unit. This, of course, should have been offset by the simultaneous aging of the equilibrium catalyst except for the fact that fresh catalyst was periodically mixed with the equilibrium catalyst. This had the relative effect of holding the equilibrium catalyst at a constant level of attrition while the tagged catalyst slowly became more attrition resistant with respect to the equilibrium catalyst.

"Soyez les Bienvenus à Montréal au Mois de Mai!"

It should be pointed out that differences in attrition between the tagged catalyst and the equilibrium unit catalyst are considered normal, and are not attributable to any effect of the Co-60 used in tagging the catalyst.

A preliminary evaluation of this possibility was made before this study using ordinary cobalt, and the results indicated that the cobalt had little or no effect on the attrition characteristics of the catalyst. It is assumed that Co-60 would act no differently than ordinary cobalt with respect to any effect on attrition.

The lower-than-calculated loss rate shown in Fig. 3 for the period after the first 80 days is interesting because it correlates with, and gives a reason for, a loss in catalytic activity which occurred during this period. It had previously been observed that during operating periods of high stack losses and no (or low) withdrawals, the catalyst in the unit decreased in catalytic activity.

The period from 52 to 127 days after the start of the test constituted just such a period. Stack losses were high; no withdrawals were made from the unit; catalytic activity in the unit decreased. Fig. 3 shows that during this time the loss rate of tagged catalyst became less than the calculated loss.

In other words, after 80 days the older, tagged catalyst was being preferentially retained in the circulating catalyst. This shows that under the conditions outlined above, i.e., high stack losses and no withdrawals, the older, less catalytically active catalyst is preferentially retained in the unit while the fresher, more active catalyst is preferentially lost out the stacks; the net result is a loss of catalytic activity in the unit.

Acknowledgment

The authors wish to express their appreciation to the many technical and non-technical men who assisted in this study and especially to the operators of the Fluid unit during the first few days after the injection of the radioactive catalyst.

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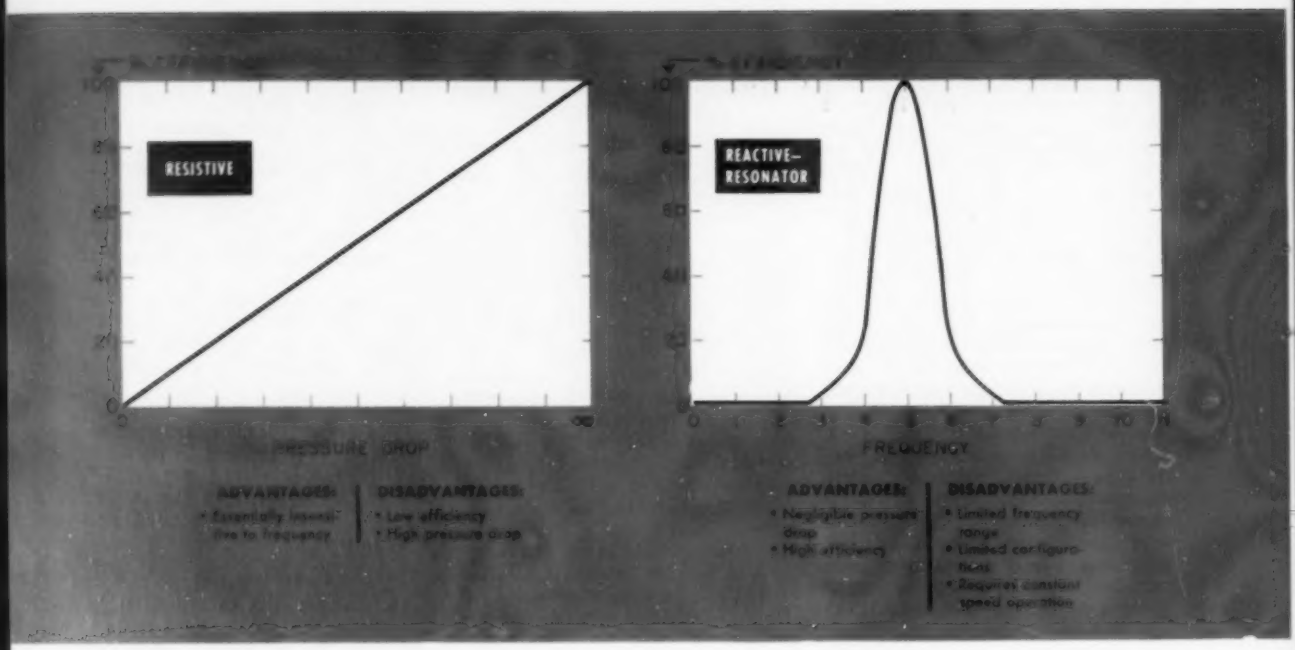
The preceding article, released exclusively to PETROLEUM PROCESSING by the Texas Co., was presented as a paper at the Forum on Commercial and International Developments in Atomic Energy, Sept. 27-29, 1955, Washington, D.C.

Meet the Authors

John J. Mitchell is a staff chemist at the Beacon, N. Y., laboratories of The Texas Co. Receiving his Ph.D. in 1941 at Johns Hopkins University, Dr. Mitchell started in the physical research department for the company. His earlier work was devoted to applying a mass spectrometer to hydrocarbon analysis and measuring thermal conductance of joints between metals. During a one year leave of absence in Sept., 1944, he worked on a confidential project for the War Dept. at Oak Ridge, Tenn. His recent work has been in the application of radioactive tracers to the study of reaction mechanisms. He is a member of the American Chemical Society, the American Physical Society, and the American Association for Advancement of Science.

A. J. Kinsella, Jr., is a chemical engineer in The Texas Co.'s Port Arthur research laboratories. Prior to World War II, Mr. Kinsella was in research work with Devoe and Reynolds Paint Co. and Tennessee State Industries. After serving three years as an army radio technician, he studied at the University of Louisville, receiving his Bachelor degree in Chemical Engineering in 1949.



Which Type of Pulsation Dampener

GAS pulsations from reciprocating compressors can be a serious problem in a compressor plant. Even under conditions of normal operation, the amplitude (peak to peak) of such pulsations is in the range of 6 to 10% of operating pressure. During abnormal operations, the amplitude may even reach above 10%.

The big problem is vibration in the piping, induced by the pulsations, both within the compressor plant area itself and also at some distance from the compressors. The vibrations can be, and are, very serious when the natural frequency of a span or a configuration of piping is equal to the frequency of the pulsations. End result is the generation of extraneous noise and dynamic stressing of the pipe with subsequent fatigue failure of the piping system.

A second problem is the adverse effect gas pulsations have on the accuracy of orifice-plate flow measurement. In some cases, recorder pens oscillate to the extent that it is difficult to determine an accurate average. In other cases, the pens are damped to the extent of drawing a smooth line on the chart whereas an error in flow measurement actually exists.

Two basic methods for controlling these pulsations are listed herewith:

1—Resistive: These are methods whose efficiency is a function of pressure drop and which consist of a reduction in area of the flow path by means such as orifice plates and valves.

2—Reactive: These are methods whose efficiency is a function of frequency and which consist of properly designed changes in pipe sections and internals such as low or high pass dampeners.

The four variations of these two types along with their attenuating characteristics, advantages and disadvantages are depicted graphically in the accompanying illustration.

Resistive types have been used most frequently in the past and are occasionally found in present-day plants in the form of orifice plates and pinched valves. However, the general use of this type is not recommended unless it is designed for a specific purpose, because some of its disadvantages override the advantages of low initial cost and small physical size.

These disadvantages are that its efficiency is a function of the gas pulsation amplitude, with generally low efficiency and high resistance to flow, or high pressure drop. Note the graph which shows a typical curve for efficiency versus pulse pressure for this type of control method.

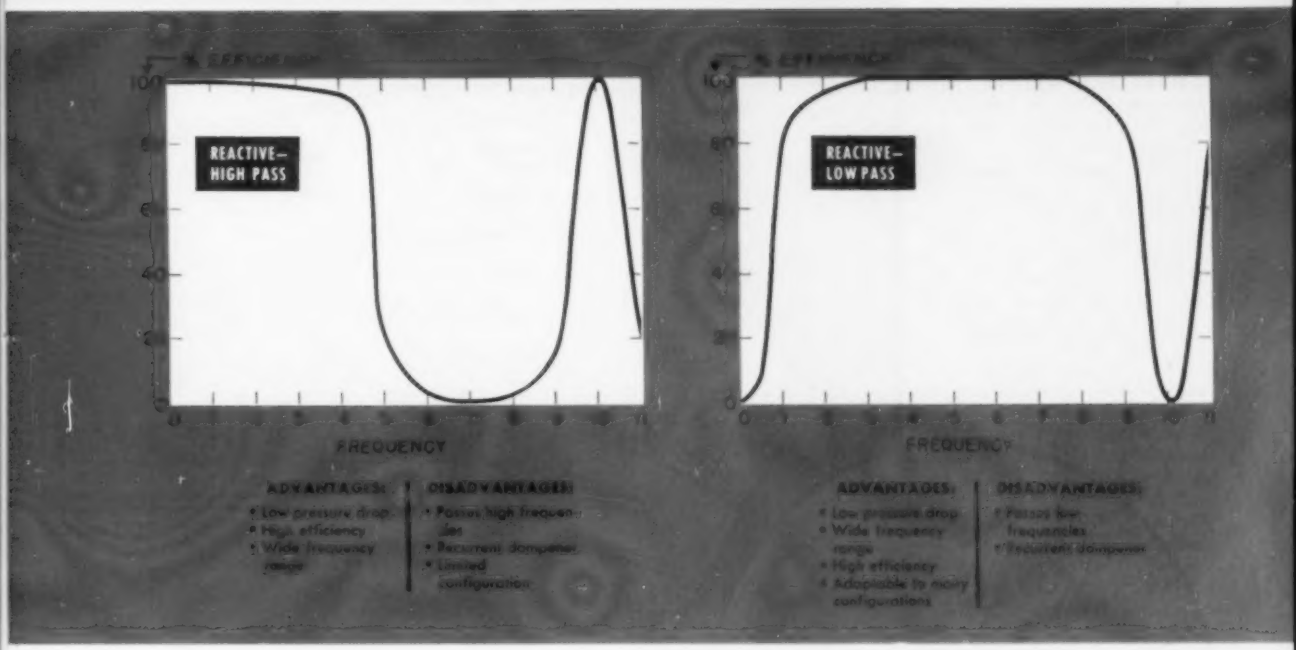
The simplest form for this method is a valve placed in the system at the point needing control. The more elaborate form, which requires a knowledge of design, is placing an orifice within a volume chamber.

Reactive types are presently in use on systems where reciprocating compressors are used to compress and transport gas. The basic reactive type dampener in turn is used in three major ways: (1) side-branch resonators, (2) high-pass dampeners, and (3) low-pass dampeners.

Side-branch resonators are absorption devices which give negligible pressure drop to the system. However, they have a limited frequency range and can be used to advantage on essentially constant speed compressors. See graph for the characteristic attenuation curve.

Forms in which this type of control device come are composed of volume chambers and orifice plates, volume chambers and pipe lengths, or just pipe lengths themselves. All forms can be attached to the laterals, the headers, or the normal surge chambers of the compressors at a side branch.

High-pass dampeners allow passage



Fits Your Compressor Problem?

of the high frequencies and attenuate the low. They can be designed to have low pressure drop with high attenuation characteristics. Note the chart for a typical curve for efficiency versus frequency for this type of control method. In order to show the recurrent characteristic, the curve is drawn arbitrarily showing a recurring attenuation peak at 10 cycles. This is a function of the physical geometry of the dampener.

Forms of the high-pass dampener are composed of a length of perforated pipe and external shell which can be inserted in the lateral (in-line) dampener, or replace the normal volume (manifold dampener) bottle of the compressor.

Low-pass dampeners allow passage of the low frequencies and attenuate the high. Like the high-pass form, these can also be designed for low pressure drop with high attenuation characteristics. The chart shows a typical curve for efficiency versus frequency, again drawn arbitrarily to show a pass frequency at 10 cycles.

In this case, forms of the device are composed of two chambers and an interconnecting pipe. They can be adapted to almost any configuration. The manifold configuration is so designed that one chamber of the dampener is used as the volume bottle for the compressor cylinder, thereby replacing the normal volume bottle.

The in-line, low-pass dampener consists of an elongated shell divided into multiple chambers with appropriate interconnecting tubes. It is inserted in the lateral piping as close to the compressor as possible.

The two-bottle dampener consists of two separate chambers connected by a properly sized tube, with one chamber serving as the manifold volume bottle and the second being inserted in the lateral. The dampening system, which considers the complete piping between the compressor cylinders and the header system as a pulsation dampener, requires the proper relationships between volume bottles, headers, and lateral piping.

How much dampening is needed to prevent vibration or metering errors? This is a difficult question to answer specifically. Each plant is slightly different in design and operation. However, some general areas of acceptable residual-pulse pressures can be ascertained. These fall into two classes:

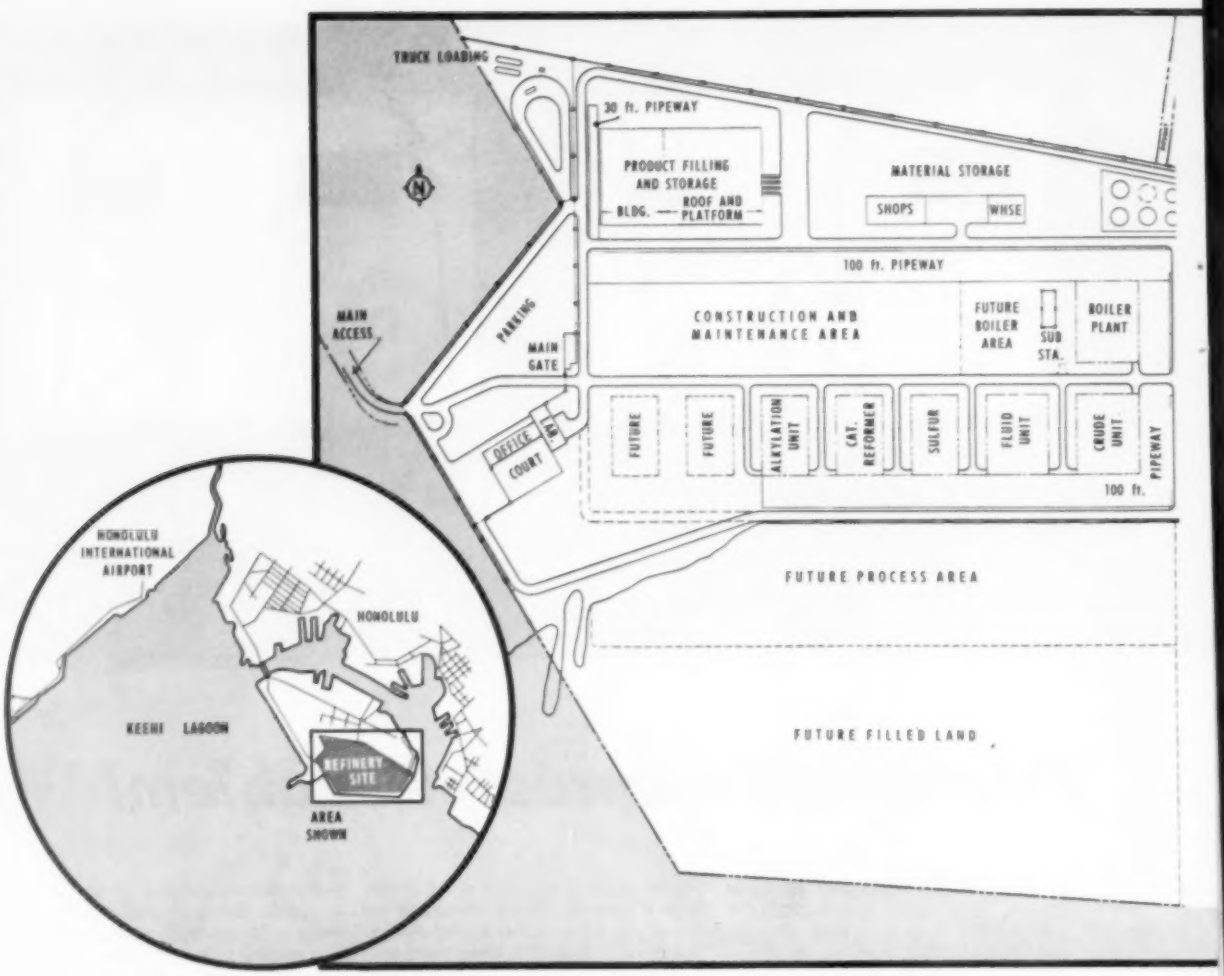
Where vibration is expected or is already prevalent, these areas fall into two categories which depend upon what the basic design of the plant is:

1—In plants which follow the pattern of grade-type piping and which are well-designed in accordance with dynamic relations for structural supports, 1¼ to ¾ % (½ peak to peak) of average pressure is acceptable.

2—In plants which follow the pattern of overhead piping, there is more room for errors in the dynamic relations of the structural supports. As a result there are two areas of acceptability: 1¼ to ¾ % (½ peak to peak) of average pressure for the well designed plants, and ¾ to ½ % (½ peak to peak) of average pressure for average designed plants.

Where metering problems exist or are expected, the maximum residual-pulse pressure ranges from ¼ to 1/10% (½ peak to peak) of average pressure and is dependent upon type and range of the meter and its position relative to the compressors.

The preceding article is based upon the paper "Control of Pulsations in Piping Systems," by C. Newman, chief engineer, Los Angeles; and N. H. Moerke, chief engineer, Paola, Kans., both of the Fluor Corp., Ltd. The paper was presented at the American Society of Mechanical Engineers' Petroleum Mechanical Engineering Conference, New Orleans, La., Sept. 25-28, 1955.



PROPOSED NEW REFINERY IN HAWAII, planned by California Standard, on site in Honolulu harbor, will follow a . . .

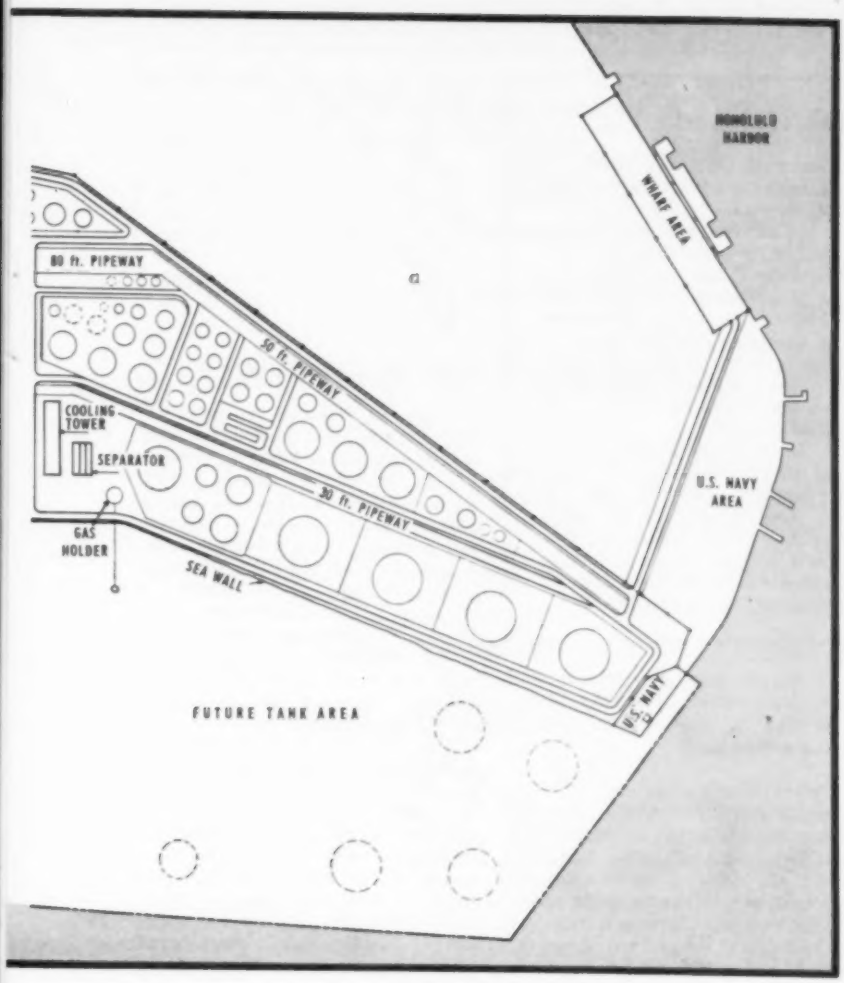
PATTERN FOR PURITY. When you start from scratch, like California Standard in Hawaii, you can design for . . .

No Smog, Pollution, or Odors

ALTHOUGH faced with one final legal hurdle before actual construction can start, Standard Oil Co. of California has now disclosed plans for its proposed 25,000 b/d, $30,000,000 refinery in Hawaii that indicate the facilities will be the last word in clean, nuisance-free petroleum processing operations.

The company has requested from the Honolulu City Planning Commission a change in zoning requirements to permit construction on Sand Island, at the entrance to the city's harbor. Public opposition to the refinery site has been mainly that the area might ultimately be better developed as a park or other tourist attraction. The commission has not yet reached a decision.

At present, the island is under military control, and the military services have agreed to the release of the land under a presidential order only if it is used for a refinery—held valuable to national defense. Should the zoning change be approved and the U.S. release the land to the Territory of Hawaii, the land will have to be put out to public bid. However there are no indications that any other refining companies will bid against California Standard.



Specific measures to prevent pollution—both in the air and in the water—as planned by the company are:

- Floating roof tanks for gasoline and other light products.
- All waste separators containing light distillates to be covered to prevent air pollution.
- All gasoline pumps will be equipped with mechanical shaft seals.
- Hydrogen sulfide will be recovered and converted to sulfur.
- Flue gas from the catalytic cracking unit will be completely incinerated.
- Electrostatic precipitators will be used to remove dust from the cracking unit flue gases.
- A closed safety relief discharge system will return gases through recompression to the refinery fuel system. Excess gases in the event of an emergency will be burned in a smokeless flare.
- An additional sanitary sewer system will be installed on the property for discharge into the main Honolulu city sanitary sewers.

Pending the outcome of the zoning appeal, California Standard hopes to start construction this fall, with subsequent completion expected by fall of 1957.

The company made an extensive survey of several locations on the islands of Hawaii, Maui, Kauai, and Oahu, before selecting the Sand Island site as most suitable for its needs.

Stanford Research Institute was retained by the company to make a study of the proposed facilities, weather conditions, and other factors, to make certain that nothing was overlooked in providing a plant that would be a "good neighbor" to the Hawaiian community. The results of the SRI analysis showed that the proposed plant will not contribute to any air contamination problem in Honoulu.

A fully-integrated refinery, the proposed plant is being designed to process crude oil delivered by tanker from California and other U.S. sources, Sumatra, Arabia, Canada, Venezuela, and other foreign countries.

A full range of products has been planned, including motor and aviation gasolines, jet fuel, diesel fuel, and heavy fuel oils. Lube oils and greases or other specialties will not be produced.

The Sand Island location is well-suited to serve as a deep-water terminal for super tankers. Wharf facilities to be operated as integral part of the refinery will be installed at the northeast side of the island. (See plot plan illustrations). Approximately one-half of the 108-acre refinery site is on filled land, and the other portion is submerged. The latter area will be filled to the extent required initially, and from time to time for later expansion.

Main Process Facilities

Incoming crude oil is to be handled first in a 25,000 b/d, two-stage distillation unit, including two fractionating columns and fired heaters, a rectifier column, and a sidecut stripper column, as well as usual auxiliaries.

Motor and aviation fuel components will be produced in a 10,000 b/d Fluid catalytic cracking unit, including feed heater, reactor and regenerator proper, and a six-column product fractionation section.

A plant for removal of hydrogen sulfide from the product vapors of the Fluid unit, and for conversion of the H_2S into elemental sulfur, will be built with a maximum capacity of 16 long ton/day. Actual production of sulfur will vary with crude source, but is expected to average 6 long ton/day.

Aviation alkylate blend stock will be produced in a 1000 b/d sulfuric acid alkylation unit. A pretreater for polymerizing the excess olefins is to be installed ahead of the alkylation unit to balance its feed composition. Capacity of the poly unit will be 450 b/d of motor gasoline.

Conventional product treating facilities will also be installed as needed.

Utilities and Services

These will include a steam plant for the high-pressure steam requirements, fresh-water cooling towers, and all

Public Fight Not Finished

Observers believe there may still be a fairly big controversy over permission to Standard Oil Co. of California to build its proposed refinery in Honolulu Harbor.

Governor King of the Territory of Hawaii is all for the project, but the Honolulu City Planning Commission, which must also approve, is uncertain. Citizens who are concerned with the alleged threat of the refinery to famous tourist attractions like Waikiki beach are growing more vocal.

The Territorial Board of Health has retained the services of a federal expert to advise on air pollution control problems. He is Hayes H. Black of the Sanitary Engineering Center of the U.S. Public Health Service at Cincinnati, Ohio. Mr. Black was scheduled to make his survey during October.

Dr. Richard K. C. Lee, president of the islands' health board, has advised Governor King that his group has already studied the plans for the refinery submitted by California Standard and a report made by Standard Research Institute, and has indicated a favorable attitude toward the refinery.

"On the basis of this material, my staff believes it is reasonable to anticipate that a refinery can be constructed and operated to prevent health nuisances, provided adequate controls are installed, and that they are operated efficiently," Dr. Lee said.

conventional service equipment. Electric power will be supplied by the Hawaiian Electric Co. from the City of Honolulu. Fresh water and drinking water will be supplied by the Board of Water Supply of the City and County of Honolulu.

A tank is to be built for storage of fresh water to assure continued operation of the refinery for several hours in the event of a temporary discontinuance of the main water supply.

Main storage facilities will consist of approximately 1,800,000 bbl. in welded floating and cone-roofed tanks for crude, intermediate, and final products. This tankage is to be integrated through interconnecting liner with 600,000 bbl. of existing tankage.

Buildings to be constructed on the refinery site will include an administration building, a laboratory, a locker and change room, mechanical shops for electrical, boiler machine, carpenter, and instrument work, and a materials store house.

The wharf facility will include a 50 x 400 ft. dock, with additional land anchors as required for mooring, and a dockside area of 125 x 300 ft. to handle package products and ships' stores.

Future Plans

Other facilities have been planned, as shown in the plot plan drawing, but may not necessarily be included in the initial installation. They include:

1—A catalytic reforming unit.

2—Barrel filling and reconditioning unit, to be installed if required to serve the military.

3—Truck loading facilities may be provided for handling certain products.

Waste Disposal

Water from process units will flow through a series of API design separators for removal of oil, and then to a colloidal air separator for final treatment and removal of objectionable materials before release to the ocean.

The volume of process effluent will be relatively small, amounting to about 1500 gpm. Final effluent water, with a pH value of 6.5-8.5, will contain approximately:

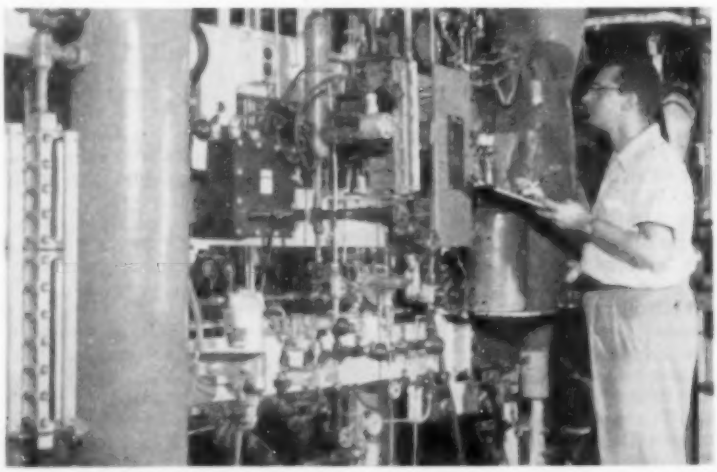
Materials	ppm
Oil	5-10
Oxygen	4
Biological oxygen demand	15-20
Sodium chloride	11,500
Calcium chloride	500
Magnesium chloride	500
Sodium sulfate	500
Silicon dioxide	40

Construction Program

California Standard estimates 19,000 man-months of construction labor will be required to build the new refinery. This will represent a payroll expenditure in the Hawaiian Islands of over $8,000,000. Island workmen and contractors will be used to the greatest possible extent. Wherever possible, materials produced locally will be used in the construction. Also, wherever possible and practical, any of the remaining equipment and material will be purchased through local suppliers, though it may be shipped in from the mainland.

After the refinery is in operation, it will employ about 225 people, with an annual payroll in the neighborhood of $1,200,000. In addition to this regular payroll, the company expects to contract for certain maintenance work locally in the amount of $250,000 yearly. Further, it expects to spend about $600,000 per year for maintenance supplies, chiefly from Island suppliers.

NEWS in VIEWS



NOT BIG ENOUGH FOR HAWAII or for any other full-scale plant, this is believed to be the smallest continuous fluid catalytic cracking unit in the Standard Oil Co. (N.J.) operations. A 4 b/d unit in the Process Research Division's pilot plant at Bayway, N.J., it has just gone through a six-week turnaround.

Where Would YOU Apply Heat to Straighten a Bent Shaft?

Four out of five answers to this question by both recent college graduates and experienced engineers are wrong. What is your solution? Study this article and then turn to page 1769 for the correct answer.

Equipment Failure Due to Heat

What is temperature gradient stress and its effects?

Six failure problems and their solutions

How to calculate temperature gradient stress

By D. J. BERGMAN
Universal Oil Products Co.

CONSTANTLY increasing process temperatures are forcing a closer scrutiny of stresses in equipment caused by temperature gradients. Only a few years ago average industrial process temperatures were as low as 350 to 500° F. Today they are up to 500 to 700° F. and still climbing. Catalytic processes in the petroleum industry are even higher than the industrial average, operating at temperatures as high as 950° F. or more.

At present, the subject of stresses in piping, vessels, or structures caused by temperature gradients has been less thoroughly covered in the interpretive or application field than in the mathematical and applied mechanics fields. The purpose here is to help fill the gap and point out areas where more accurate analyses are needed.

Three different systems of stresses may be set up, with regard to the effects of yield in the case of high stress and short time, or creep in the case of long exposure to lower stress at high temperature. In Fig. 1, these are illustrated by simple mechanical cases.

In case **a**, yield of the simple beam, caused by a load producing stress above the elastic limit, results in no change in moment or stress. In case **b** too much cold spring of a bent pipe between fixed supports causes stress above the elastic limit and consequent yield. Hence the natural length of the pipe is increased and the stress is decreased from that figured on the basis of a completely elastic system. In case **c** yield in the beam stressed above the elastic limit allows the load to deflect outwardly and increases the moment arm of the constant load. Hence, moment and stress increase, resulting in accelerated yield, and probable failure.

These loading systems should be constantly kept in mind when considering cases of differential temperature stress, since in many cases the satisfactory working of a structure at economic cost may be dependent upon case **b**. Fortunately most cases of stress caused by differential temperature are of this nature.

Furthermore, it is important not to consider only the steady-state condition, because transient stresses caused by temperature lags during start up or shut down of a system may be higher than those of the steady state, and cause failure. In the petroleum industry, most people are aware that piping failures generally occur during the adjustments due to starting or shutting down a plant.

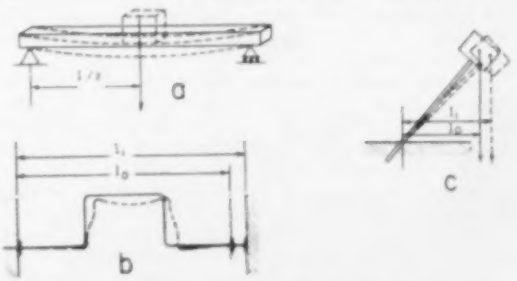


Fig. 1—EFFECT OF YIELD on stress systems

This article is based on a paper presented by Mr. Bergman at the Petroleum Division of the American Society of Mechanical Engineers' Petroleum Mechanical Engineering Conference in New Orleans, La., September 25-28, 1955.

Just What Is Temperature Gradient Stress?

FUNDAMENTALS

Differential Temperature Effect On Flat Bar, Plate, and Pipe

An elementary analysis of an application of differential temperatures is presented in Fig. 2. If a straight flat bar of low-carbon steel be maintained without restraint with one surface at 900 and the other at 1000° F., we would expect to have it bow as shown in Fig. 2**a**. We also would expect to have a uniform gradient of temperature from face to face, so that the mid-point would be at 950° F. and other points would have temperatures directly proportional to the distance from each of the surfaces.

For simplification let us consider that the temperatures are brought up slowly and uniformly so that permanent deformation does not occur because of temperature shock. Further, let us disregard variations from the linear temperature distribution assumed, which may be caused by loss of heat from sides or ends.

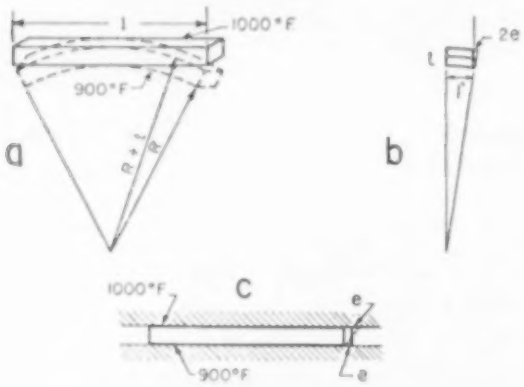


Fig. 2—EXPANSION of free and restrained bar

At this temperature level the coefficient of expansion is approximately 0.000010, so the difference in natural length of the two surfaces of the bar is 0.000010 × 100 = 0.0010 in./in. The free bar bows as a result until this differential length is the difference between the arc length of the inner and outer faces, from a center with radii of R and $R + t$ (see calculations, p. 1736 and Fig. 2**b**). With a free bar there is little or no stress due to this bowing, as each differential layer maintains its natural length at the temperature imposed.

However, consider the case if restraint is placed on the bar to maintain the two faces flat. Fig. 2**c** shows the bar held straight with the hot face now compressed by one half of the differential expansion or 0.0005 in./in. and the cooler face extended by the same amount. Of course the whole bar has expanded, due to the difference between atmospheric temperature and the 950° F. average.

The elastic stress in the outer fibers of the bar may be calculated as follows on the basis of elastic strain, and the stress pattern across the thickness is shown as the solid line in Fig. 3:

$S = eE$
S = stress
e = strain
E = Young's modulus of elasticity
$S = 0.0005 \times 25 \times 10^6$ (at 950° F.)
$= 12{,}500$ psi

Looking slightly further, the modulus of elasticity will vary across the thickness of the bar with the temperature, so for elastic conditions the hot face might be expected to be compressed slightly more than the cooler face was elongated, changing the stress pattern across the thickness.

However at a temperature of 1000° F. the proportional limit of carbon steel is approximately 9000 psi., so that yield occurs. On the cooler face at 900° F. the proportional limit is approximately 12,500 psi. so that here the steel behaves elastically for short time loading. Because of yield on the hot face elongation will be greater, and stress less than if the steel were elastic. This is shown by the dashed line in Fig. 3.

Furthermore, creep stresses for low-carbon steel[2] for 0.10% in 1000 hr. are 2700 psi. and 13,000 psi. at 1000° F. and 900° F., respectively. So creep occurs on both faces, and inward toward the neutral axis as long as the stress remains above the creep values. This still further decreases the maximum stresses, and makes them distinctly nonlinear across the thickness. This is illustrated in the short dashed line in Fig. 3.

The creep which has occurred is shown by the departure of the stress curve across the thickness of the bar from the prolongation of the straight portion of the curve indicating the elastically stressed portion of the thickness.

Now consider what happens when the bar is cooled back down to atmospheric temperature after say 4000 hr under these temperature conditions. The top fiber has shortened due to both yield and creep, and the bottom fiber has lengthened due to creep, and in this process the stresses near the two surfaces have diminished.

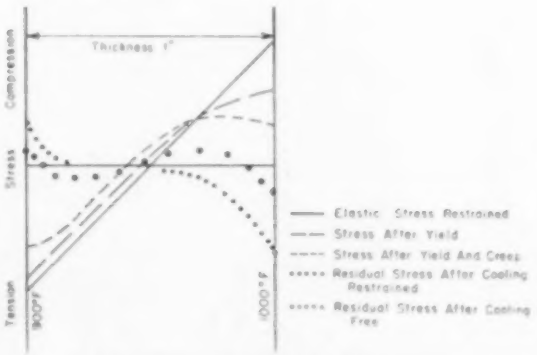


Fig. 3—STRESS due to differential temperature

When brought back to atmospheric temperature, the top fiber wants to be shorter than the shape of the bar will permit by the amount of yield and creep which has occurred, and likewise the bottom section wants to be longer. So a reversal of stress occurs, the top being under tension and the bottom under compression. In this case

the stress at the outer fibers would be obtained by multiplying the permanent deformation by the value for Young's modulus in the cold condition. The dotted line in Fig. 3 shows the residual-stress pattern when the bar is maintained under restraint during and after cooling.

If the restraint holding the bar flat is removed after cooling there will be a bow in the opposite direction, owing to the fact that the hot face has been upset and the cooler face permanently stretched. The stress pattern then is shown by the circled curve in Fig. 3. Part of the permanent deformation which has occurred is taken up by bow and the rest by residual stress which is much smaller than under the restrained conditions.

This illustrates the complications involved in trying to arrive at actual values of stress under simple conditions of differential temperature. Confirming in a general way this qualitative analysis, Clark[1] gives data on creep tests of killed carbon steel by the Barr and Bardgett method in which a specimen stressed to an initial value of 11,000 psi. at 1000° F. dropped in 24 hr. to a value of 4000 psi., while a similar specimen stressed to 11,000 psi. at 900° F. dropped to 8000 psi. in the same time.

In most cases, because of the greater strength of the cold metal, the residual stress will be well below the cold yield point. So although there is a residual stress, no ill effects occur. When the material is reheated the residual stress starts decreasing, passes through zero and then reversing, increases up to the working conditions again.

Taking a slightly more complicated case of a flat plate, Fig. 4a shows the result of temperature differential, in that the plate attempts to assume a spherical shape. As long as the differential is small it can do this with little or no stress, but for large temperature differentials the necessity of bending in two directions introduces stresses even though the plate be free. If the plate is restrained at the edges, or over all, stresses are set up which may reach values high enough to cause yield or creep.

Formulas for calculation of the stress in a round or square plate held at the edges are given by Goodier,[2] but in application of them, if the stresses calculated are above

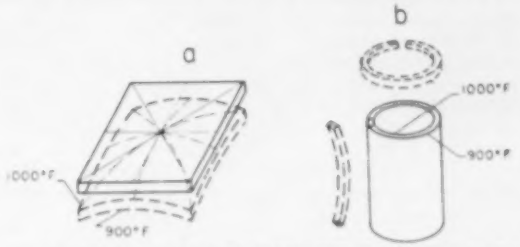


Fig. 4—EXPANSION OF FLAT PLATE AND THICK PIPE due to temperature gradient

yield or creep values at the temperatures given, the elastic conditions on which they are derived no longer apply.

Taking one step further, consider the thick-walled tube in Fig. 4b subjected to temperature differential due to flow of heat from inside to outside. Because of the inherently stiff shape of a cylinder it is impossible for the metal to move and relieve the stresses set up by the temperature gradient as happens with the free bar. A longitudinal strip cut out of the pipe would bow as would the bar discussed earlier. Hoop stresses prevent this. A circular element slit at one point would open up because of the increase in natural length of the inner fiber compared to the outer one, but this cannot occur in the pipe either. So all the pipe can do is take the stresses set up, with no opportunity for relief except through yield and creep.

Six Failure Problems and Their Solutions

PROBLEM 1

Bulging Spool Pieces in Catalytic Cracking Units

That the stresses set up in such a case can be material is illustrated by a carbon-molybdenum spool piece installed on one of the wartime catalytic cracking units in place of a second slide valve in the regenerated catalyst standpipe. This spool, made of 1¼-in.-thick carbon-molybdenum steel and flanged on each end, was cut through the middle, installed in the line and welded to make a neat fit in the piping. Since it was so short that bolt heads interfered, no insulation was provided around it.

After some months of operation it had bowed outwardly above and below the weld line. In seeking for reasons, the obvious ones of high temperatures, internal pressure, and end load due to an expansion joint seemed to be possible causes. It was expected that more uniform operation with no runaway temperatures would prevent any further deformation. But deformation went on.

The possible reasons just outlined were then investigated and the stress due to internal pressure and end load were each evaluated to be less than 200 psi. Such a stress is too low to cause the deformation found. However, Timoshenko[6] gave a formula for differential temperature stress at inner and outer fiber in the following way:

$$S = \frac{Ea\,(t_1 - t_2)}{2\,(1 - u)}$$

Where: S = stress
E = Young's modulus
a = coefficient of expansion (0.00001 at 950° F.)
$t_1 - t_2$ = radial temperature gradient across shell (100° F.)
u = Poisson's ratio = 0.3

Substituting in this formula for the values assumed, the stress appears to be

$$S = \frac{25 \times 10^6 \times 0.000010 \times 100}{2\,(1 - 0.3)} = 17{,}800 \text{ psi}$$

Perhaps it might be questioned whether 100° F. is a reasonable temperature drop across the 1¼-in. thickness of the pipe. Curves for loss of heat from bare pipe in still air, indicate values of the order of 7000 Btu/hr. Flux values of 30,000 Btu/hr. are given in Kern[5] for water. So a figure of 20,000-25,000 Btu/hr. for a rain-washed pipe appears to be reasonable. At a temperature of 950° F. the conductivity of steel is approximately 275 Btu/hr./sq. ft./in. of thickness. For 1¼-in. thickness the conductivity is 275/1.25 = 220. Then dividing the heat flux

by the conductivity to get the temperature drop gives a value of the order of 100° F.

The stress found in the foregoing is based upon elastic conditions which naturally do not hold at this temperature. Variations in temperature plus complete cooling at shut downs resulted in so much permanent deformation that this detail had to be replaced.

Another similarly located spool piece in a different catalytic-cracking unit also started to bulge, causing concern over possible failure. It was recommended that the piece be insulated, and also that the outside temperature of the pipe wall be measured. This spool piece was located immediately over the slide valve controlling flow of fluid catalyst at a temperature of 1100° F. The following table gives temperatures as determined approximately with "Tempilstiks":

Side of Pipe	11 am	1:30 pm	2 pm	2:30 pm
North	500-550	500-550	500-550	500-550
East	950-1000	550-600	650-700	650-700
South	500-550	800-850	950-1000	950-1000
West	500-550	Below 500	650-700	600-650

At this time the spool piece had a diameter of 18 1/16 in. at the flanges, and 18 7/16 and 18 11/16 in. in the middle. These data indicate temperature gradients of at least 28 degrees per in. circumferentially, as well as high radial gradients. However, it does not seem that there would be much more than 100 degrees actual radial gradient through the pipe wall. It is probable that the large differences around the circumference were due to catalyst settling and packing along the inside of the pipe wall above the slide-valve deck. Occasional variations in the slumping of this catalyst would result in the changes with time.

In the case of another of the wartime catalytic-cracking units, the insulation on the inside of the regenerated catalyst standpipe rat-holed out and resulted in high wall temperatures. This line wrinkled in several places and the surprising thing was that it actually became reduced in length owing to the very high temperature differential stresses caused by 1100° F. catalyst on the inside and atmospheric temperature outside. It shortened a total of approximately 4½ in. from its original cold length of 90 ft.

PROBLEM 2

Tube Distortion in a Thermal Cracking Unit

Luster[6] in 1930 developed the optimum thickness for a tube under internal pressure and subject to heat input from the outside. In this case the temperature gradient through the tube wall tends to increase the length of the outer fibers with respect to those of the inside wall. So the tube expands to something approximating the circumference comparable to the average wall temperature with compression in the outer fibers and tension in the inner fibers. At the same time the internal pressure puts tension completely across the thickness of the tube although in the case of thick tubes the tension stress is higher at the inside than the outside fiber.

Combining these two stresses, as shown in Fig. 5, shows a high tension at the inner face and a comparatively low stress at the outer face. For the optimum thickness of tube the stress at the outer face would be zero. In the example given in the paper an 18-8 tube of 5 in. OD by ⅜-in. thick wall is shown as having an inside hoop stress of approximately 12,200 psi. with a heat input of 10,000 Btu/sq. ft. of outside tube surface. It should be recognized, particularly in the case of radiant wall tubes, that the localized heat-transfer rate on the fire side of the tube will be considerably above the average heat input so that the calculation of the differential temperature stresses on the fire side would result in values about 80 per cent above those given. Furthermore, heat-input rates of up to 15,000 Btu/sq. ft. of outside surface may be found in the petroleum industry and even much above that in the power field.

Application of the formulas in Luster's paper to a number of existing thermal-cracking units with carbon-steel tubes resulted in calculated stresses so much above the yield point that failure might well have been expected.

Yet these heaters had in many cases operated satisfactorily for years. Apparently the calculated high stresses

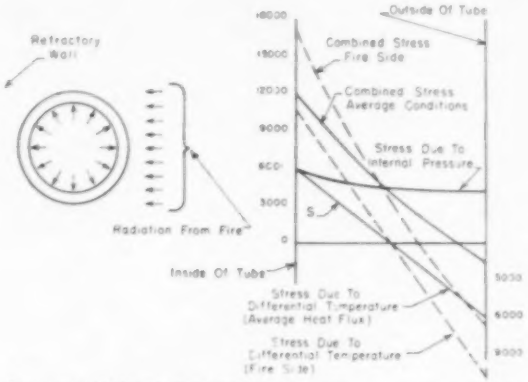

Outside Of Tube
Refractory Wall
Combined Stress Fire Side
Combined Stress Average Conditions
Stress Due To Internal Pressure
S
Radiation From Fire
Inside Of Tube
Stress Due To Differential Temperature (Average Heat Flux)
Stress Due To Differential Temperature (Fire Side)

Fig. 5—STRESSES IN TUBE subject to internal pressure and high heat transfer

were something that did not occur in practice since Mother Nature took care of this situation by allowing the metal to yield and creep on the inside while the tube was hot, resulting in a reversed stress of compression on the inside and tension on the outside wall of the tube when it was cold.

In order to check the validity of this theory, a 3¾-in. OD by ⅜-in. wall ID tube was slit on the wall side. The saw kerf was 0.053-in. and after cutting through the wall the slit opened to 0.078-in. Although the heat rates are not available, there seems to be little question but that the inside of the tube was in compression and the outside in tension due to relief of the high tension stress at the inner wall of the tube because of yield and creep under operating conditions.

For calculations, see p. 1736, under Problem 2, which derives the amount of spring which might be expected on slitting a tube in this way on the assumption that the heat input had occurred uniformly from all directions and that the residual-stress pattern across the tube wall when cold was a straight-line function. Neither of these assumptions is accurate, but using the formula as an approximation, the extreme fiber stress in the tube wall was found to be 5500 psi.

The adjustment which occurs in a tube wall subject to high heat input densities follows along the idea expressed in Fig. 1**b**; namely, that stress relief or relaxation of the tube due to yield or creep reduces the stress in the steel from that calculated for elastic conditions to a value approximating that due only to internal pressure. Accordingly, it appears entirely safe based upon years of experience, to design tube-wall thickness for an allowable creep stress caused by internal pressure only. Perhaps this should be limited to relatively thin-wall tubes.

PROBLEM 3

A Bowed Bar in the Lining For a Pressure Vessel

A good example of the effects of localized heating is illustrated in Fig. 6. This occurred during consideration of a proposed method of lining a pressure vessel with a $^{7}/_{64}$-in. layer of 12 chrome steel. The proposed method consisted of welding vessel rounds for an 8-ft.-diameter vessel 10 ft. long, fitting sheets of liner as closely to the inside wall as possible, and then with the vessel course mounted on dollies, rotating it slowly while a continuous-feed automatic welding head burned through the 12-chrome liner into the steel-vessel wall.

Several different types of rods, including 25-20, 25-12 and 18-8, several different rod diameters, and variations in welding voltage and current were tried to determine the best procedure to obtain a satisfactory weld bond between liner and vessel steel. This was done on a flat slab of $^{5}/_{8}$-in. steel at the shop.

After completion of these tests a section 6 in. wide by 30 in. long and containing about 12 welds spaced evenly along the 30-in. length was sent into the office for examination. It was observed that this strip of steel was bowed to the extent that the two ends rose $^{5}/_{16}$-in. and the question of residual stresses resulting from the welding operation came up. It was calculated that were the steel bar to be forced into a flattened position, stresses of approximately 30,000 psi. would be the result, and since this was assumed to be similar to the case where the vessel course already welded up was unable to move to relieve itself these stresses would be locked in the steel unless the vessel was stress-relieved.

Since many vessels have been successfully protected against internal corrosion in the field by hand welding strips of 12-chrome steel at 2½ to 4-in. intervals without stress-relieving, perhaps we may give secondary consideration to the earlier problem.

If the liner were applied to a flat sheet of steel constrained to remain flat the yield and creep which would occur, stretching each of the welds as it cooled, would result in a different natural length on the lined side so that

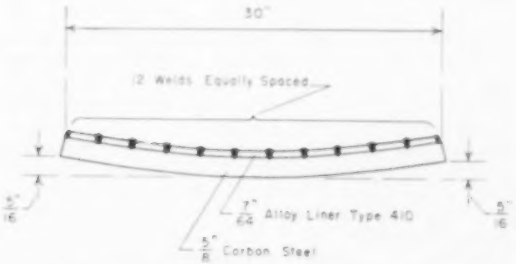


Fig. 6—LINES PLATED with welds on 2½-in. centers

although the sheet would indeed try to bow toward the welds the amount of permanent deformation during plastic condition would be greater and the calculated average residual stresses due to welding would have been considerably reduced. The fact that the welding had been applied to the sheet in a free position allowed it to adjust itself on cooling with a minimum of yield giving a greater bow and indicating higher stresses than actually would be the case of the constrained vessel wall.

For a method of calculating the apparent stresses due to flattening a free circular arc of steel, see p. 1736 under Problem 3.

PROBLEM 4

Stresses Resulting at the Junction of Noncompatible Metals

An allied problem dealing not with stresses caused by differential temperatures but with a differential expansion between noncompatible metals is illustrated in Fig. 7. In this case, a 5-chrome pipe has been welded with 25-20 chrome-nickel rod and subject to an operating temperature of 1000° F. The coefficient of expansion of the 5 chrome between 70 and 1000° F. is approximately

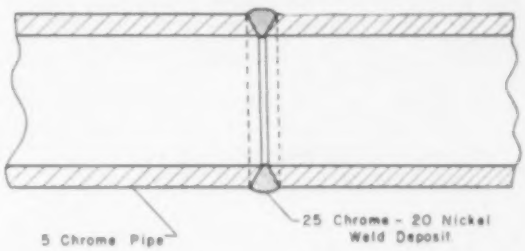


Fig. 7—FIVE-CHROME PIPE WELDED with 25/20 Cr-N rod

0.0067-in. per in. The expansion of the 25-20 weld deposit over the same temperature range is approximately 0.0083-in. per in. 25-20 has a lower expansion rate than either 18-8 or 25-12 which perhaps is the reason why it has become popular as a field welding material for low-chrome alloys.

The modulus of elasticity of 25-20 at 1000° F. is about 22.5×10^6 while the modulus of elasticity of 5 chrome is approximately 25×10^6. Disregarding this difference in modulus of elasticity which would tend to throw a somewhat greater amount of the deformation in the 25-20 alloy deposit, we may take an average modulus of elasticity of 23.7×10^6. Assuming what is highly improbable, that the two dissimilar metals were stress-relieved to have essentially zero stress at 465° F. and that the elongation of the 5 chrome and shortening of the 25-20 weld material were equal, the elongation and compression of each metal would amount to one-fourth the difference between the two expansion rates given previously, or 0.00035-in. per in. The stress on an elastic basis would be $0.00035 \times 23.7 \times 10^6 = 8300$ psi.

The creep stress of 5-chrome steel at 1000° F. is given as approximately 7000 psi. for 1 per cent creep in 100,000 hr. Accordingly, some creep may be expected. Although this joining of dissimilar metals has not been looked on with favor by metallurgists, its use, particularly in the petroleum industry, has grown over past years as a field-welding procedure for piping using preheat and then letting the weld cool slowly instead of using compatible rod with the requirement of careful stress-relieving. Some have encountered microscopic cracking in or adjacent to the weld but the practice has been expanded and the power industry is also using it, as indicated by papers presented by Lien, Eberle and Wylie, and by Weisberg and Soldan at the Annual Meeting of the ASME in 1953.[7, 8]

Cycling tests resulted in surface notches and subsurface cracks in the fusion zone. Removal of the cracks which showed up and continued operation under test conditions indicated that the welds would be safe for operation in spite of the apparent high stress level caused by the dif-

ferential expansion. It is probable that the thickness of the materials thus welded together plays a very important part in the stress pattern. While the procedure works very satisfactorily for thin pipe, it should be considered questionable for thickness over 1-in.

A quantitative study of the residual stresses in a composite bar of carbon steel clad with a heavy corrosion-resistant lining of type 347 alloy is given in the report of the American Petroleum Institute task force assigned to study the requirements for welded pressure vessels constructed of internally clad plate. This report is dated May 10, 1955. This was obtained by cutting a slot successively deeper in the bar and noting the change in bow. This study shows a complicated stress pattern because of the use of two dissimilar materials fastened rigidly together.

PROBLEM 5

Ruptures in Metal due to Vapor Barrier in Insulation

Fig. 8 illustrates two examples of a vapor barrier, or flat ring which projects through an insulating layer, and is exposed to high temperature on the inside and is welded to the pressure-vessel shell along its outside diameter. Under operating conditions with a temperature of 1000

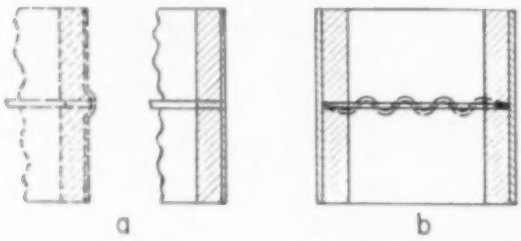


Fig. 8—VAPOR BARRIERS to protect equipment interiors

to 1150° F. on the inside and approximately 350° F. on the outside shell, there is a considerable difference in the natural lengths of the outer and inner fibers, caused by the temperature differential.

In the case of the thin ring and heavy shell shown in Fig. 8a, the inner part of the ring assumes a scalloped or wavy shape, thus relieving the high stresses which would have been set up if the ring were to remain flat. The increased natural length of the inner ring is the difference in developed lengths of the waved inner fiber, and the length of a circle of that diameter. In Fig. 8b the ring is too heavy and stiff laterally to deform in that way so the outer fibers and a portion of the shell are stretched while the inner fiber is under compression. The stresses that are caused under these circumstances may be high enough to rupture the shell.

PROBLEM 6

Bulging Coke Chamber and Distortion in Supports

As an important example, consider the case of a coke chamber and its supports. These vessels have been built in sizes up to 17 ft. in diameter and up to 80 ft. tangent lengths. They are subjected to unusually severe temperature shocks by their operating conditions. They may go through a cycle of operation and cleanout every 24 hr. During this time the vessel is brought up to a temperature of approximately 850° F. by vapor and liquid from the coking heater.

As the coke level builds it acts as an insulating layer, and loss of heat through the vessel insulation gradually cools the lower portion of the shell down to a temperature of perhaps 400° F. while the upper part is still in the 850° F. range. It should be appreciated that there are differences in operating technique and process, such as top or bottom feed, high or low pressure and temperature, which may affect the shell temperature in detail, but not particularly in principle.

When the coke level gets up to about 75 or 80% of the vessel volume after perhaps 12 or 14 hr. of operation, the flow from the heater is switched to an empty vessel, and the connecting lines are blanked off for cleanout. Pressure is reduced to a sump, allowing vaporization of liquid from the top of the coke bed, and steam is introduced at the bottom of the vessel in order to further vaporize liquid and start cooling.

After steaming for a period of perhaps 1 hr., water is pumped into the bottom of the chamber. The hot coke turns this into steam often resulting in high local pressures because of the volume of steam generated, and resulting in a quick drop in temperature of the vessel walls. This temperature drop proceeds up the chamber as the coke becomes cooled down to water temperature. Hence it is possible for the bottom of the vessel to be at a temperature of 100° F. while the top is in the order of 700° F. As the vessel wall cools it also tries to contract.

The coke, formed when the vessel is hot, does not have nearly as high a temperature coefficient of expansion, and so the cooling operations may set up apparent high internal pressures approximating the ultimate compression or crushing strength of the coke. Following the cooling the vessel is unheaded and the coke is removed, either by mechanical drilling or hydraulic jets.

From whatever cause, wave of cooling during operation, further wave of cooling due to introduction of water, transient differences in temperature from inside to outside of shell due to water cooling, or high equivalent pressures due to crushing the coke, it is common experience for these vessels to swell in service and cases are known where a 10-ft. diameter 1⅝-in. thick vessel swelled to 10-ft. 6-in. diameter in the course of about eight years of operation.

This swelling was mainly between the circumferential welds. It appears that the weld metal, having a cast structure, was not subject to creep or yield as much as the rolled plate. Application of a 2-in. gunnited concrete lining to the inside of the shell, even though it had a low insulating value compared to the external insulation, greatly suppressed this swelling action, presumably by cushioning the temperature shocks on water cooling.

In some installations using the mechanical drill for coke removal, a skin of coke 2 or 3 in. thick is left on the shell of the vessel and this probably acts in the same way, even though its conductivity is higher than the concrete. Thin-wall vessels will show less tendency to bulge than thick ones, because of lower temperature difference across the wall.

While the vessel wall is thus being mistreated by the frequent and relatively fast temperature changes, another point of high stress concentration may be set up at the vessel support. Many hot vessels have been supported on lugs welded to the vessel wall, which in turn rest on a concrete or steel beam, as shown in Fig. 9a. Because the weight of the vessel acts offset from the point of support,

a moment is produced which must be resisted by tension at the lower, and compression at the upper, attachment of the lug to the vessel wall.

To minimize these moment stresses the lugs usually are made relatively long along the wall, and the offset from the vessel is minimized as much as possible. Frequently it is recognized that these support stresses are in addition to the design basis of internal pressure, and compression and tension rings are added at the top and bottom of the lug. When these rings are welded flat to the shell and insulated there is not a great temperature difference, but sometimes a designer will endeavor to gain an advantage in section modulus and strength by installing the reinforcing rings

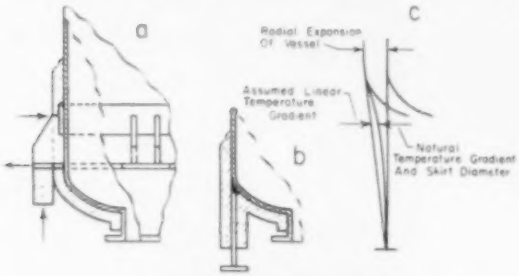


Fig. 9—HOT VESSEL SUPPORTS

edgewise extending 4 or 5-in. out from the vessel and perhaps even outside of the insulation. Then differential temperature problems are again liable to appear.

An additional load thrown into the vessel wall that is frequently overlooked is the fact that the lugs, even though placed on sliding bearing supports, still require a considerable force to start moving. And move they must, because a 10-ft. diameter vessel heated from 100 to 900° F. will expand approximately ¾-in.

In expanding, a push results at the bottom and a pull at the top of the lug attachment to the vessel. When cooling occurs, the reverse is true, and the compression at the top of the lug attachment caused by dead load plus wind load is increased by the moment of the friction force of the lug on the support plate.

The combination of high and variable loads thrown into the side of the vessel shell led to consideration of skirt supports for high-temperature vessels. Early difficulties with cracking at the weld between vessel head and skirt of some coke chambers appeared to be due to the use of a short thick skirt, further stiffened by the lugs provided on the skirt for anchorbolts. Consequently the temperature transition skirt was evolved. As shown in Fig. 9b the skirt support is welded to the head of the vessel and is insulated over most of its length.

The skirt is normally made of ⅜ or ½-in. plate and may be from 3 to 5-ft. long depending upon vessel weight, temperature and diameter.

At the point of attachment of the skirt to the vessel both are at the same temperature, hence have the same natural diameter due to temperature. At the support, the support plate and lower part of the skirt are losing heat to the atmosphere, and since this heat must travel the long narrow path through the skirt there is a considerable temperature drop and the bottom of the skirt is close to the temperature of the support, hence no expansion need be provided for. At intermediate points the skirt diameter varies with the skirt temperature with practically no stress with the exception of the zone near the vessel head weld. Here internal pressure in the vessel causes expansion and hoop stress which are transmitted also to the skirt.

It may be theorized that the top of the skirt, being fixed at the head, must remain parallel to the vessel wall, and then change in direction as indicated by the temperature gradient. Wolosowick[9] analyzed this condition and set up a formula for the stress due to bending. He gives an example for a skirt 130 in. diameter, and ½-in. wall thickness with a vessel temperature of 700° F.

The calculated flexural stress is given as 9350 psi. Skirt length is not given but solving back his equations the temperature gradient is found to be 3.5° F. per in., corresponding to a 15-ft. skirt. Since the formula indicates stress to be proportional to the temperature gradient, the calculated stress for a gradient of 25° F. per in. would be 67,000 psi. This is above the ultimate strength of the steel.

The bending stress indicated by this formula must be accompanied by departure of the neutral axis from the natural line of the temperature gradient, and this departure would result in hoop stress of much greater magnitude than the bending stress. Therefore it appears that development of hoop stress forces the skirt to follow closely the natural temperature-gradient line.

If heat loss from the skirt occurs through the insulation, or if the inside of the skirt is not insulated, the rate of temperature drop per inch of skirt length will be greatest near the head and least near the support, resulting in a curve for the natural diameter of the skirt along its axial length. This will still further increase calculated stresses based on an end condition parallel to the vessel wall.

Against this, pressure and loss of heat through the skirt from the end of the vessel wall tend to incline the end of the wall inward in the direction of the temperature-gradient line, decreasing stress.

Several hundred vessels, ranging up to reactors of catalytic-cracking units 27 ft. in diameter, have been supported by this means with no trouble where consideration was given to provision of a temperature transition skirt with gradients of the order of 15 to 25° F. per in.

Therefore it appears that practice should outweigh calculations indicating stresses far above the yield point, since these calculations are based on elastic properties and lose track of the natural adjustments caused by temperature, yield, and creep. After all, the rolling and forming operations in the manufacture of a pressure vessel all result in stresses above the elastic limit, in order to achieve the desired shape. So as long as the conditions are such that the stress is reduced as yield occurs, failure should not be expected, even though the stress-relieving which occurs during operation may result in residual stress during shut down.

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How to Calculate Temperature Gradient Stress

See "FUNDAMENTALS"

Bow in a free bar as a result of differential temperature

Please refer to Fig. 2b:

$$2e/t = 1/R \text{ and } R = t/2e$$

where: e = ½ differential expansion between inner and outer faces of free bar, in./in.
t = thickness of bar, in.
R = radius, in.

For a steel bar, 1 in. thick, with temperatures of 1000 and 900° F. on the two faces, the radius of curvative would be as follows:

$$e = (0.000010 \times 100)/2 = 0.0005 \text{ in./in.}$$
$$R = 1/(2 \times 0.0005) = 1000 \text{ in.}$$

As a rule, these bows are of relatively large radius, and the subtended arc is small. So by an approximation the height between the chord and the inside of the bow may be obtained as follows:

where: h = height from chord to bow
c = chord length (approximately arc length)

Approximately:

$$2h/(\tfrac{1}{2}c) = (\tfrac{1}{2}c)/R$$
$$h = c^2/8R$$
$$R = c^2/8h$$

See "PROBLEM 2"

Amount of spring in a tube slit on the wall side

In order to make an approximate evaluation of the residual stresses in a heater tube after service, see Fig. 10. Assuming that the heat input has been continuous around the circumference of the tube and the stress distribution across the thickness is linear, the residual stress may be found as follows:

Measure the inside diameter and thickness of a short section of the tube. Then slit and measure the gap formed when the tube opens up (allowing for saw kerf).

Before the tube is cut, the ratio of outside circumference to 1-in. of inside circumference is:

$$[2\pi(R_o + t)] / [2\pi R_o] = 1 + t/R_o$$

After the tube is slit and allowed to move so as to eliminate the residual compression at the inside face and the tension at the outside face, the outside circumference will decrease and the inside will increase by S/E in./in. each.; where: S = extreme fiber stress, and E = Young's modulus of elasticity.

Therefore, after the cutting, the ratio of outside to inside circumference is:

$$1 + t/R_o - 2S/E$$

The tube will expand to a new diameter:

$$R_i = R_o + \text{gap}/2\pi$$
$$(2\pi R_i + t)/2\pi R_i = 1 + t/R_o - 2S/E$$
$$1 + t/R_i = 1 + t/R_o - 2S/E$$
$$t/R_i = t/R_o - 2S/E$$
$$R_o tE = R_i tE - 2SR_iR_o$$
$$2SR_iR_o = R_i tE - R_o tE$$
$$S = tE(R_i - R_o)/2R_iR_o$$
$$R_i - R_o = \text{gap}/2\pi$$
$$S = tEg/4\pi R_iR_o$$

This was used to determine the cold residual stress in a tube from a thermal cracking heater. The tube was carbon steel, 3¾ in. × 5/16 in. wall. Heat rates are not available.

It was a roof tube, fired from one side, so the residual stresses would not be expected to be uniform. However, slits made at different points on the circumference show the following:

Fire side	0.029 inches gap
Roof side	0.028 inches gap
Side next to adjacent tube	0.025 inches gap
Average	0.027 inches gap

Taking the average of these gaps, the calculated stress is:

$$S = \frac{0.312 \times 30 \times 10^6 \times 0.027}{4 \times 1.96 \times 1.875} = 5500 \text{ psi}$$

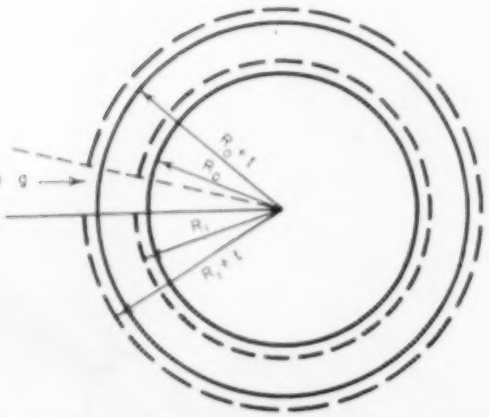


Fig. 10—EXPANSION OF SLIT TUBE SECTION due to residual stresses

See "PROBLEM 3"

Apparent stresses due to flattening a free circular arc

The stress due to straightening a bar bowed with radius R may be found as follows. In straightening the bar, the outside is compressed and the inside is stretched ½ the total difference in length per inch of inside diameter.

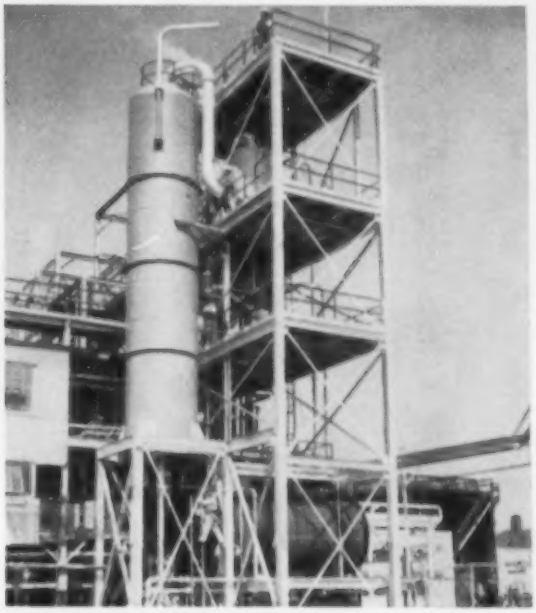
$$R = t/2e$$
$$e = S/E$$
$$S = tE/2R$$

For a bar 30-in. long and 5/8-in. + 7/64-in. = 0.734-in. thick with a bow of 5/16-in. at the middle:

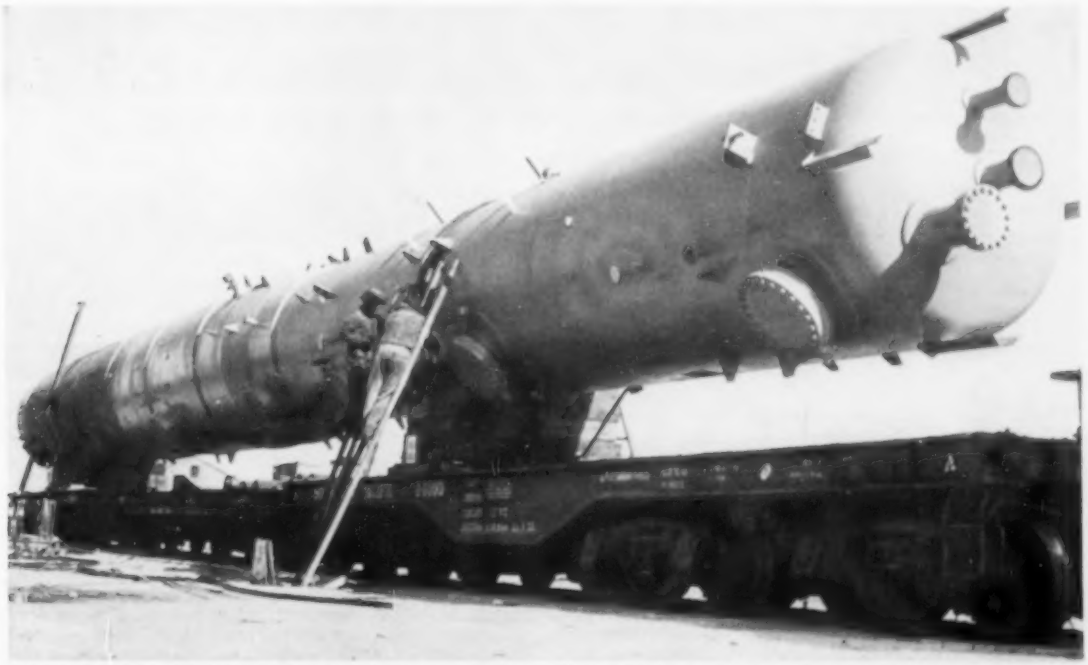
$$R = \frac{C^2}{8h} = \frac{30^2}{8 \times \frac{5}{16}} = 360 \text{ in.}$$

$$S = \frac{tE}{2R} = \frac{0.734 \times 30 \times 10^6}{2 \times 360} = 30{,}600 \text{ psi.}$$

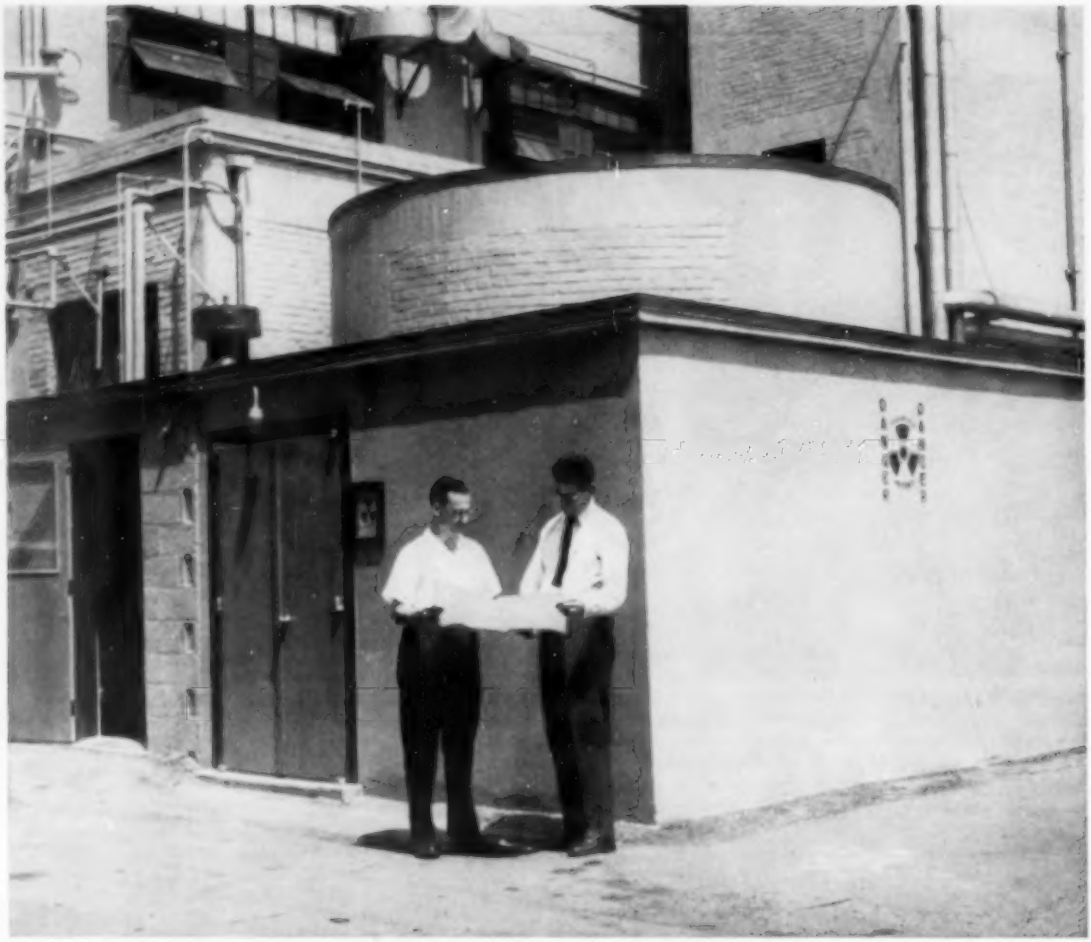
MINNESOTA'S LARGEST REFINERY, Great Northern Oil Co.'s 25,000 b/d, $20,000,000 installation at Pine Bend, went on stream last month with the operation of main crude oil valves by W. J. Carthaus, president (left), and M. T. McCants, plant manager



INCREASED OUTPUT IN COLD RUBBER at the Akron synthetic rubber plant of Firestone Tire & Rubber Co. is represented in part by this new latex concentration tank and its 80-ft. supporting tower. Firestone is also expanding its production facilities at Lake Charles, La.



BIG JOB FOR BIG UNIT FOR BIG REFINERY—Three railroad flat cars were required to ship this 126-ft. steel pressure vessel from the San Francisco plant of United States Steel Corp.'s Consolidated Western Steel Division to the new Shell Oil Co. 50,000 b/d refinery at Anacortes, Wash., a $55,000,000 installation



NEW ELECTRON GUN in "pillbox" at Atlantic Refining Co.* one of the firms investigating the possibilities of . . .

Refining Through Radiation?

Seven oil companies with nine test units are actively researching for the right answer

TODAY'S petroleum processors are not standing still waiting to see what others are doing in the field of atomic radiation research.

The seven oil companies now known to have radiant energy research facilities in various stages of development (see box) are all studying the technique as a possible tool to use in processing petroleum hydrocarbons.

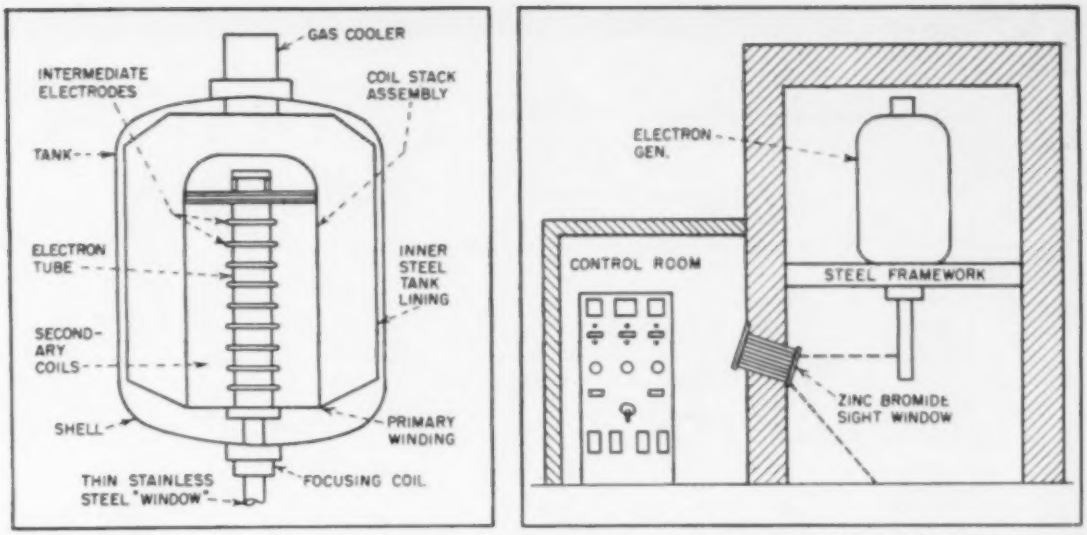
One of the most recent firms to disclose details, Atlantic Refining Co., has had its laboratories in operation for about five months. Atlantic's approach is via the so-called electron gun, illustrated on these pages and discussed more fully below. It is said to be the only industrial electron gun in operation among East Coast oil companies. However, similar equipment has been in use elsewhere for crude oil exploration work.

Other oil companies and their plans have been announced in recent months, and the status of those plans are shown in the accompanying scoreboard.

* Outside of the "pillbox" housing Atlantic's generator, chemical research supervisor Dr. Vincent J. Keenan explains its operation to a staff member.

Atlantic's electron gun, a one million electron volt (1 mev) resonance transformer built by General Electric Co., accelerates atomic particles (electrons) moving inside a vertical tube to a speed of 600,000,000 mph. by magnetic coils. These high-velocity particles, emerging through a thin metal "window," are used to bombard test samples and impart the energy required for breaking apart and reforming hydrocarbon molecules.

One interesting experiment already performed has been the production of small amounts of hydrazine, a rocket



HOW IT WORKS—the electron beam generator is diagrammed in this interior view (shown in the drawing left); arrangement of "pillbox" (right)—control room is separated from test area

fuel, by bombarding ammonia with particles from the electron gun.

The new accelerator is visualized by H. W. Field, Atlantic's vice president of research and development, as the next step in preparing petroleum products. It is an important part of Atlantic's $5,000,000 per year research program.

Up to now the industry has relied on heat and pressure to wring more efficient fuels from the crude, through cracking and polymerization. It is hoped that the use of energy in the form of accelerated atomic particles will give a more exact tool for the breaking and remaking of hydrocarbon molecules.

Dr. Field describes the accelerator as "a scalpel which can get between the atoms, slicing off only those parts desired." This is opposed to the treatment of crude by other sources of energy which resembles the "sledge hammer" approach, in which many molecules are broken apart in the hope that the right combination will result when the fragments recombine.

Although gamma radiation sources (radioactive cobalt) offer greater penetrating power and perhaps more potential for chemical conversion, Atlantic has chosen the electron gun because it is safer, less expensive and offers a more exact tool. The electron accelerator, both the linear and the Van de Graaf types, can have the radiation halted at will by throwing a switch, leaving no residual radiation. With radioactive sources, it is mandatory that personnel be protected at all times from the constant emission of radioactivity.

The lower penetrating power of beta rays does not require the thick walls needed with cobalt-60 sources. However, some protection for the operator while the accelerator is activated is required. At their research laboratories, Atlantic Refining has used an existing 2-foot thick wall "pillbox" of reinforced concrete to trap any stray radiation during tests. Viewing is done through an 18-in thick port faced with plate glass and filled with a zinc bromide solution.

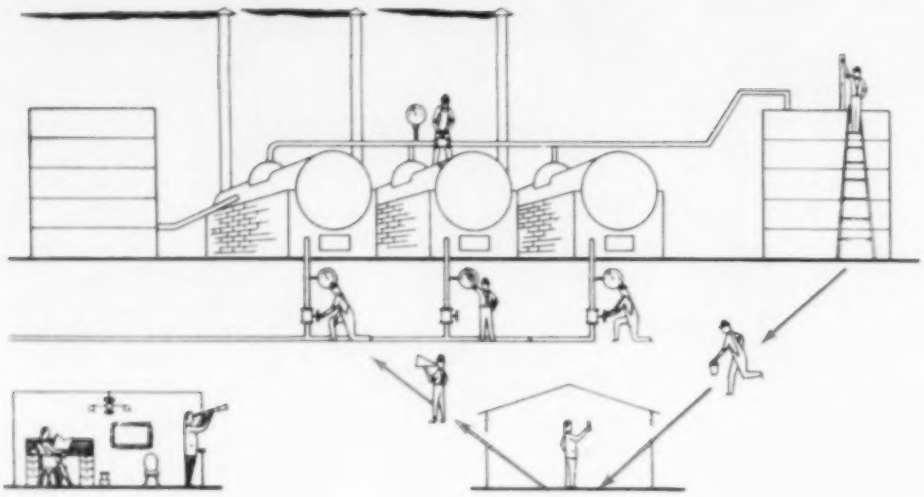
The effects of radiation from an electron beam generator are already known to the chemical industry by the successful radiation of polyethylene into a harder and more heat-resistant product, as well as the successful sterilization of food.

The same tool, it is predicted, will help the petroleum industry squeeze more high octane gasoline from each barrel of crude, and perhaps result in the development of totally new products. Atlantic's program will follow a path of working first on pure compounds, and then applying the technique to processing selected cuts

Atomic Radiation in the Oil Industry

Company	Location	Radiation Type	Radiation Source
Atlantic Refining Co. (operating)	Philadelphia	Beta (electron)	Linear Accelerator 1 mev (at present)
California Research Corp. (operating)	Richmond, Calif.	Gamma	Cobalt, radioactive
Esso Research & Engrg. Co. (operating)	Linden, N. J.	Gamma	Cobalt, radioactive 3500 curies
Gulf Oil Corp. (announced)	Harmarville, Pa.	Beta	Van de Graaf 3 mev
Humble Oil & Refining Co. (operating)	Baytown, Texas	Beta	Van de Graaf
Shell Development Co. (operating)	Houston, Texas	Beta	Van de Graaf 2 mev
Shell Development Co. (announced)	Emeryville, Calif.	Beta	Van de Graaf 3 mev
Socony Mobil Oil Co. (operating)	Dallas, Texas	Beta	Van de Graaf 0.5 mev
Socony Mobil Oil Co. (announced)	(not revealed)	Beta	Van de Graaf 2 mev

Yesterday



Significant Trends in Control

Predictions on automation have been coming at us thick and fast these days. However, instrument engineers G. G. Gallegher and R. A. Robinson of the Fluor Corp., Ltd., Los Angeles, delivered a paper a few days ago at the New Orleans meeting of the American Society of Mechanical Engineers which developed one of the clearest outlines we have ever seen of what the future may hold for control engineering in the petroleum processing industries. This article has been adapted from that paper.

FUTURE trends in automation would not be difficult to predict if we could predict the optimum goal accurately. However, what appears to be the optimum goal today may not be the optimum goal tomorrow.

What is today's optimum goal? A definition will help us separate future trends from future fads.

A practical goal would seem to be a process that will *not* necessarily start by itself, but once started will continue to operate economically and precisely and effect minor repairs automatically until it is shutdown. It is an operation which will include the analysis of feed stocks as well as market requirements to produce required product purity and quantities automatically.

Present-day instrumentation makes it possible to design a plant to meet this goal, including "self-repair." Processes today accomplish this feat to a limited extent. Spare pumps are often instrumented so as to start automatically on the failure of the main pump. The same thing can be done with emergency turbo-generators and instrument air systems. In the completely automatic plant, this thinking would need to be used much more extensively than today.

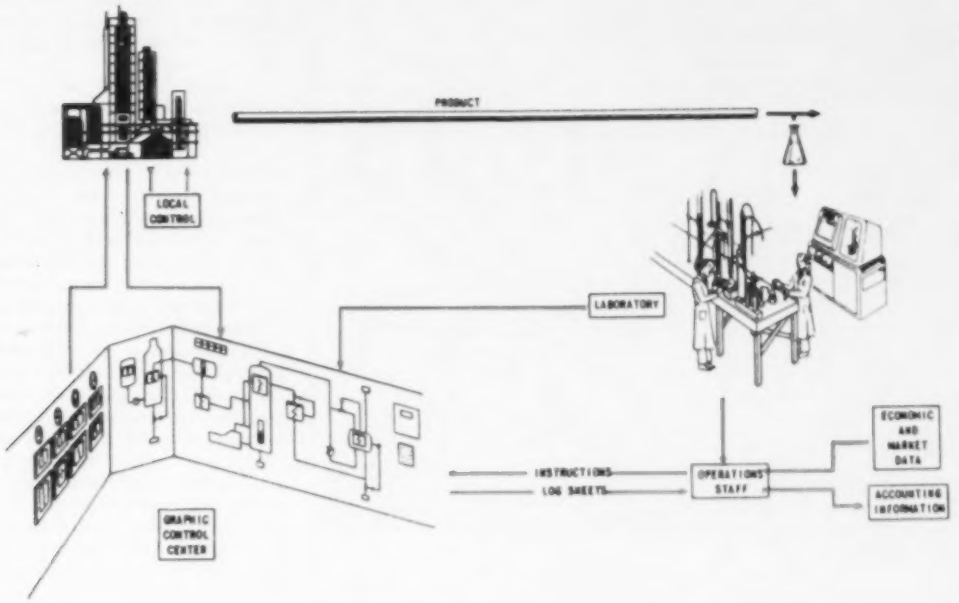
Can complete automation be justified economically? Or is it even desirable technically? At present, probably not. Refineries now operate at a nearly irreducible low operating manpower level per plant, enough to meet emergencies safely. The few men needed can be upgraded technically by provision of automation for their routine tasks, but they are still needed in attendance for safety reasons and for evaluation of the process.

Economically then, we should not duplicate with equipment some of the tasks men can do better or cheaper. These same men can start up and shut down the plant, rather than employing very specialized equipment for the purpose. It hardly seems economical to automate such functions as turning water on and off to condensers, opening block valves, etc.

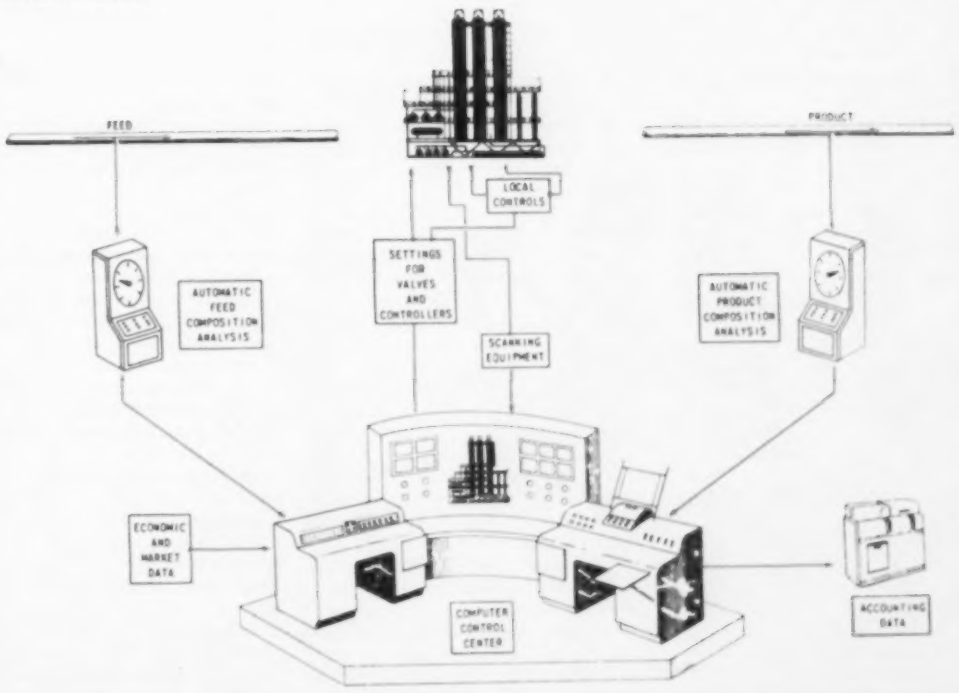
The Past Is Prologue

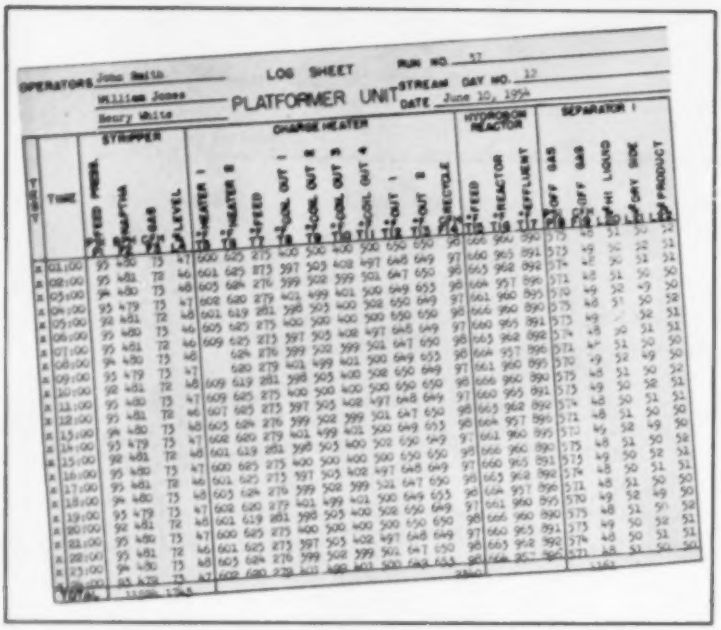
Not many years ago, the control element for a process consisted of a man who watched an indicator and manipulated a valve to maintain a desired reading. As the limits of this man's capabilities were reached and it was not practical—or even possible—to increase production by adding

Today



Tomorrow





LOG SHEET — PLATFORMER UNIT — RUN NO. 57 — STREAM DAY NO. 12 — DATE June 10, 1954

OPERATORS: John Smith, William Jones, Henry White

HOUR	TIME	STRIPPER: FEED PRESS.	STRIPPER: BOTTOMS	STRIPPER: GAS	STRIPPER: LEVEL	CHARGE HEATER: HEATER A	HEATER B	FEED	COIL OUT A	COIL OUT B	COIL OUT C	COIL OUT D	COIL OUT 4	OUT 1	OUT 2	RECYCLE	HYDROFORM REACTOR: FEED	REACTOR	EFFLUENT	SEPARATOR I: OFF GAS	OFF GAS	HI LIQUID	DRY SIDE	PRODUCT
						T9	T10	T12	T6	T7	T8	T11	T13	T14	T15		T16	T17	T18	T19	T20	T21	T22	T23
A	01:00	95	480	73	47	600	625	275	400	500	400	500	650	650	98	660	960	890	575	48	51	50	52
A	02:00	95	481	72	46	601	625	273	397	503	402	497	648	649	97	660	965	891	573	49	50	52	52
A	03:00	94	480	73	48	605	624	276	399	502	399	501	647	650	98	665	962	892	574	48	51	50	50
A	04:00	95	479	73	47	602	620	279	401	499	401	500	649	653	98	664	957	896	572	48	51	49	50
A	05:00	92	481	72	48	601	619	281	398	505	400	500	650	650	97	661	960	895	575	48	51	50	52
A	06:00	93	480	73	46	605	625	275	400	500	402	498	648	649	98	666	960	890	573	49	52	52	52
A	07:00	92	481	72	46	609	625	273	397	505	408	497	648	649	97	660	965	891	574	48	50	51	52
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A	24:00	95	479	73	47	602	620	279	401	499	401	500	649	653	98	664	957	896	571	48	51	50	50
TOTAL		11088	1743																					

A TOOL OF THE FUTURE HERE TODAY: automatic logging of multiple variables once an hour shown on this 24-hr. report for a process unit.

more men, the controller was developed and put to use.

This relieved the man of his tedious job of keeping a single indicator on the desired set-point, and it upgraded him. His scope now included supervising many controllers, thus requiring a broader over-all knowledge of the process.

As processes grew in size and complexity, it became necessary to centralize the control mechanisms for more efficient supervision by the operator. It became increasingly important to measure new variables and learn to use them for control also. Simultaneously, there has been a continuous improvement and refinement of the control mechanisms themselves — the operator's working tools. One of the principle routine chores for the operator now is keeping a log sheet and watching for possible trouble.

Where We Stand Today

Progress then has established these three basic trends.

1—Reduction of the human links in process control.

2—Development of new measuring devices which more completely define product composition.

3—Continued improvement of established equipment.

There is one more trend which has begun to take form today, computer control. This is the key to what seems the future trend in instrumentation for process control.

The Tools of the Future

Present-day control mechanisms are sometimes called "error type," because they require a deviation from their set point to produce a corrective action. With a coordinated computer type control system, the instruments downstream from a disturbance will be advised that a change is coming—not that it has already happened. A corrective action can then be made in anticipation of the change. Therefore, no deviation (or error) from the control point need take place. With proper input signals, computers can analyze feed stock, product quality, markets, operating economy, and the like—and dictate the control conditions.

The log sheet today is probably one of the largest single bits of human drudgery left in operations. The log sheet should indicate the pulse of the operation. It should provide a vital source of corrective information on behavior of the process during upsets.

It is not performing its functions effectively today. For example, some refineries require as many as 360 points to be logged each period in one control center. Because of the time required to read and record this much information, it is humanly possible for one person to log only on a two-hour basis. Frequently there may be intervals of 20 minutes to one hour or more in some plants between important log sheet entries, thus destroying the relative time relationship of the data.

In addition to this problem, it is not uncommon for plant upsets to occur at the normal log period. This demands the operators' time, so he is forced to skip taking readings, and perhaps simply enters duplicates of previous ones. Unfortunately, the correct readings is the very information that is needed to prevent further recurrences of the upsets and reduce rerun and downtime.

Automatic logging and data reduction equipment is the answer to this problem. Such machines not only print the hourly log sheet in a manner of minutes, but may be equipped with scanning mechanisms to watch over the critical points between logging periods. Any off-normal points will sound an alarm and be printed either on the log sheet or a separate typewriter. With a little additional equipment, the instrument can also manipulate process quantity readings into usable accounting data and transmit such information to a remotely located accounting office. Furthermore, it can reproduce the data in some directly usable form, such as a ledger or a punched card.

The trend is pretty firmly established. At the present time, there are approximately five operating refinery installations of automatic logging instruments and four known to be in the planning stage.

How does scanning help process control? Suppose, for example, we are taking the hourly log of a gas concentration unit. If we are fortunate enough to be logging the depropanizer at the very instant an upset commences in that unit, we would have a rare piece of data. Or, if the upset occurs at some column downstream of the depropanizer at the logging time, its origin may be difficult or even impossible to determine. Upsets can occur and be controlled between log periods and never show on a manual log sheet. With data-handling equipment, plant upsets can be watched as they originate and progress through the entire chain of processes.

A process scanner with off-normal printing installed as a part of the system would detect the off-normal condition when it occurred in the depropanizer. All off-normal values and the time of their occurrences would be typed automatically at some rate—say once per minute—until they returned to normal.

As the upset progresses from the depropanizer to succeeding units, the

scanner continues to sample every important variable; and when it deviates from accepted limits, print the time and magnitude of the variable. This action continues until all points again return to normal accepted limits.

Thus, with data handling equipment we will be able to obtain our first accurate study of the interrelation of multiple-process units. Such studies will surely reveal the possibility of interprocess feedback loops that will permit us to attenuate disturbance waves before they reach the end product.

Optimalization — a tongue-twister intended to define that much sought after goal, the self-adjusting controller —may be at hand. The various controller settings we use for a given set of conditions may be optimum for those particular conditions yet require changing for different loads.

With an automatic handling data system, we may be able to make time studies that will tell us the proper moment to change these functions and how much to change them.

More efficient storage may be another possibility through automatically obtained data. It may be possible to eliminate off-plot intermediate storage and even reduce inner plant storage. Not all these things will necessarily be desirable. Reduction of storage facilities can result in the plant being operated on an "all up or all down" basis. Trouble in one unit could require a complete plant shutdown.

The marketing data feedback loop has recently become a highly automated field. Data processing equipment is becoming quite common in the accounting and time-keeping sections of most large refineries.

Its use in fields other than petroleum seem to indicate a continuing expansion in applications. Food and clothing stores are installing continuous inventory equipment that brings the inventory up to date automatically the minute a sale is made. In a large department store in Los Angeles, all sales items have price tags with a removable, punched tab. When the sale is made, this tab is removed and inserted in a slot in a receiving instrument at the sales desk. This receiver interprets the punched holes in the tab and performs several functions simultaneously: 1) a receipt is produced for the customer, 2) the sale is recorded in the accounting department, and 3) the sold item is removed from the inventory records. This type of information coupled with current market reports and seasonal requirements prove invaluable assistance to the purchasing department.

In another application, the stock market in Canada recently installed an automatic memory drum that records instantly the latest market prices and reads them out on demand from a telephone call.

Several petroleum companies have adopted packs of punched cards instead of the conventional credit cards. Although credit card sales are only a relatively small percentage of total business, they are nevertheless a predictable part and constitute a valuable source of market information. When the data is on a punched card it is in a form ready to be fed back automatically.

In the refinery itself, our individual control systems have feedback loops and so does our over-all system. However, at present this information feedback is largely a manual operation. The plant operator receives information from the laboratory on analysis of product streams, or management analysis of the market requirements.

Quality control, though speeded up greatly during the past 10 years, still involves another slow human link, the laboratory. Great strides have been made, and will continue to be made, in this area. Product composition analyzers such as spectrographic instruments and the like, are moving from the laboratory out into the plant.

Here we have an important future trend. Consider some of the possible benefits to be derived from continuous feed stock analysis, for example. We may be able to obtain a form of anticipatory control. Changes in the composition of the feed could indicate new set points for our present types of controllers. The necessary changes could be made in each process unit at the proper time as determined by the data handling equipment.

Optimalization could be achieved by computing from the feed characteristics and the process rates the new settings for the various control modes.

Product analysis, too, is a logical basis for control in our campaign to raise the level of operating efficiency and quality of product. Like feed analysis, the data feeds back and control is continuous.

Full computer control is within reach, therefore, as these various feedback mechanisms become perfected —data handling equipment and continuous stream analyzers. One further trend becomes evident because of the relationship of these components of over-all process control—the greater use of electronics. Fundamentally, all these developments are electronic devices, and a satisfactory marriage of all of them at some future time requires that they be compatible.

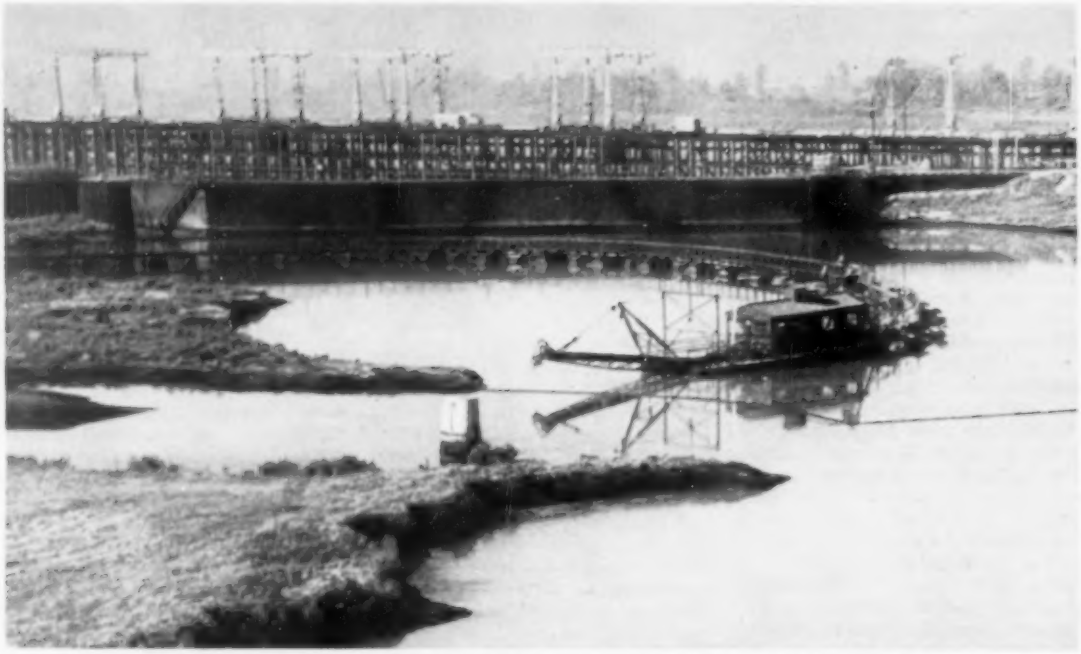
That plant of the future still seems to be within the pattern as outlined in the discussion of a practical goal. It will use manual operation for start-up and shutdown. However, once brought on stream, it will be under the control of a master computer.

NEWS in VIEWS

BIGGEST CRACKER TAKES SHAPE. Workmen are preparing huge foundation for 102,000 b/d Orthoflow catalytic cracking unit now being built at new 130,000 b/d refinery under construction by Tide Water Associated Oil Co. at Delaware City, south of Wilmington, Del.

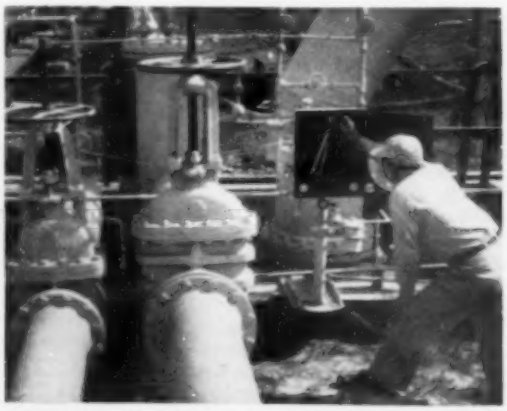
Esso Cuts Waste *AND* Pollution

in 4 Ways: 1-Equipment 2-Inspection 3-Publicity 4-Training



1 **EQUIPMENT.** This dredge with pipeline trailing behind it is Esso Standard Oil Co.'s final step in reducing oil losses at its Baton Rouge, Louisiana, refinery. 90% of the oil in the mud and silt which it raises is recovered for use as feed stock. Separating tanks save another 1,800 b/d from the waste water.

EQUIPMENT. This unit recovers about 25 t/d of sulfur from odorous hydrogen sulfide in refinery gases which used to be burned. The sulfur is used nearby.

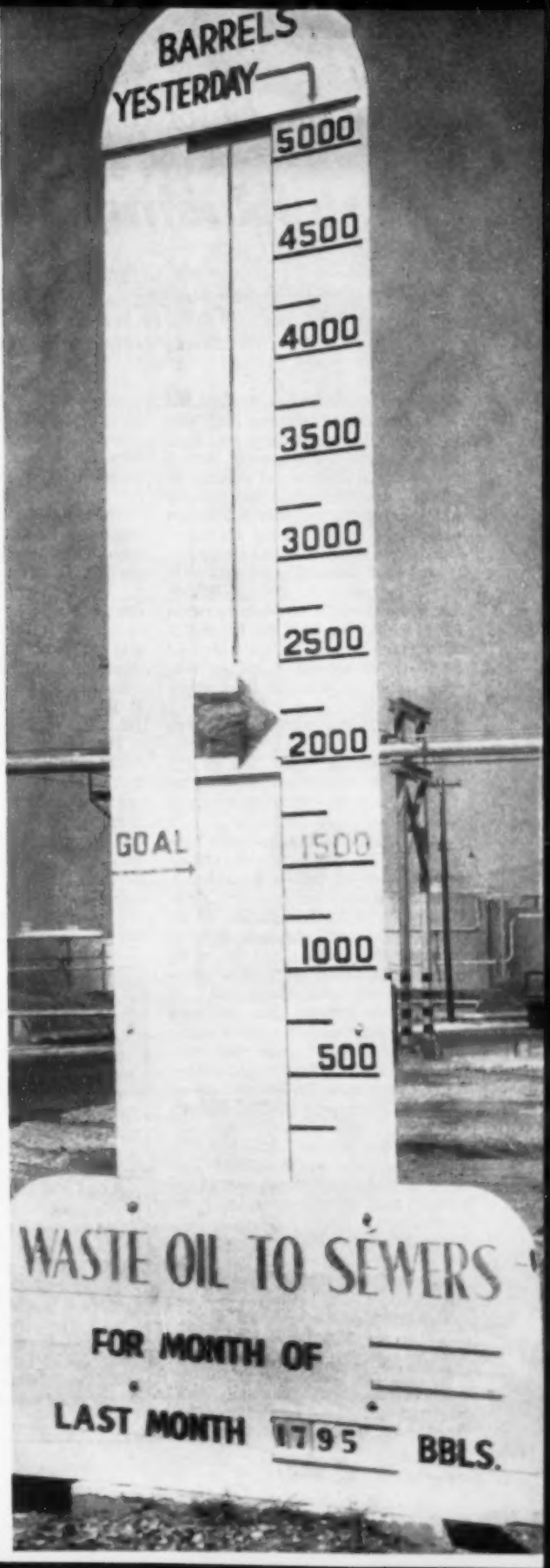


EQUIPMENT. Air pollution is closely controlled by this meter which indicates both steam quantity needed to prevent smoke at flare stack and quantity of gas burned.

2 **INSPECTION.** Top: Sampling sewage for sign of losses. Above: Comparing clean water entering plant with polluted effluent water.

3 **PUBLICITY.** One of two "thermometers" showing employes the amount of oil escaping from various refining operations to sewers. Employes cooperation decreased this loss at Baton Rouge by 50% in 5 years.

4 **TRAINING.** This group of foremen is learning the principles of reducing liquid losses, considered an important part of antipollution drive.



Methylene Chloride for . . .

Raising Solvent Flash Points

By J. J. DeVOLDRE and M. J. SKRYPA
Solvay Process Div., Allied Chemical & Dye Corp.

MANY excellent hydrocarbon and oxygenated solvents are very flammable. In large scale usage, flammable solvents are extremely hazardous materials. Chlorinated solvents, although non-flammable, are usually rather expensive and may not always possess the proper solvent characteristics. Some time ago it was found that mixtures of flammable solvents with carbon tetrachloride are appreciably less flammable. These mixtures retain the properties of both the flammable solvent and carbon tetrachloride and often exhibit solvent properties that are superior to either of the component solvents.

However, industry has recently been made aware of the high toxicity of carbon tetrachloride vapor and of the necessity of eliminating carbon tetrachloride from its operations wherever possible.

This necessitated substituting another volatile, non-flammable, chlorinated solvent for carbon tetrachloride in the above described mixtures. Methylene chloride, which fulfills all of these requirements and is in addition non-toxic, has been found to be an excellent substitute for carbon tetrachloride in this application.

Up to the present little has been published on the flammability (flash and fire points) of such methylene chloride mixtures. As a major vendor of methylene chloride, Solvay Process undertook the project of obtaining this data.

Twenty-six common, flammable industrial solvents were chosen for study. It was intended that this group include most of the common, flammable industrial solvents and also that it include solvents that are representative of the various organic functional groups generally found among solvents.

The Interstate Commerce Commission criterion of flammability for solvents was adopted for this study. The ICC considers a solvent non-flammable if it exhibits a flash point only at a temperature higher than 80° F. in the "Tag" open cup tester. All solvents flashing at 80° F. or below must bear an ICC red label when moved through interstate commerce. Many state and local fire ordinances also follow this criterion of solvent flammability.

The flash and fire points of various mixtures of methylene chloride and flammable solvent were determined for each of the twenty-six solvent systems studied. This data is recorded in Table 1. The flash point data is also presented in a series of graphs included in this report. From this data we were able to establish, for each of the twenty-six systems investigated, the composition of the mixture that flashes at 80° F. This data is recorded in Table 2.

The mixtures listed in Table 2 represent the borderline between flammable and non-flammable regions. In any particular methylene chloride-flammable solvent system, a mixture containing a higher concentration of methylene chloride than the mixture listed in Table 2 will be non-flammable.

This information enables one to determine the composition of non-flammable mixtures for any of the solvent systems studied. Considered from another view point, this work indicates the amount of cheap flammable solvent that can be "dumped" into methylene chloride without making the resultant mixture flammable by ICC standards.

The graphs plotting flash point versus composition indicate the degree of flammability that may be expected at the various concentrations of methylene chloride in the mixture.

Why Methylene Chloride?

The problem of toxicity with carbon tetrachloride, otherwise satisfactory as a flash point elevator, has helped to push methylene chloride into the picture as the non-flammable chlorinated component of solvent mixtures comprising a chlorinated compound and a flammable organic co-solvent.

Reported for the first time in this article are the flash and fire points for six groups of methylene chloride-flammable solvent systems. See charts on opposite page. The article also makes a comparison between the effectiveness of carbon tetrachloride and methylene chloride as a flash point elevator.

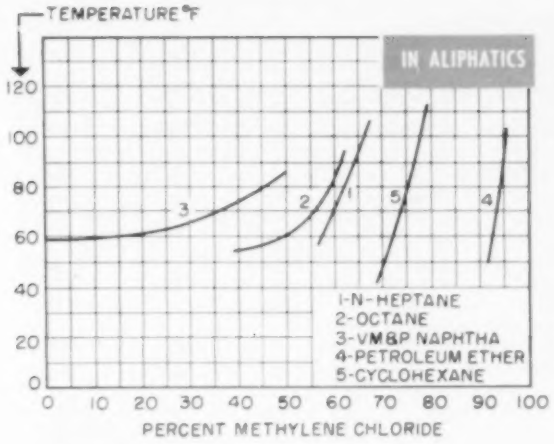
Flash and Fire Point Tests

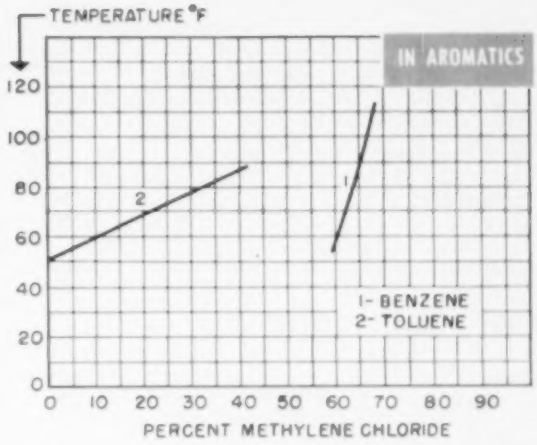
The flash and fire points were determined by ASTM Method D1310-54T using a Tag open cup tester. The procedure of this method was strictly followed.

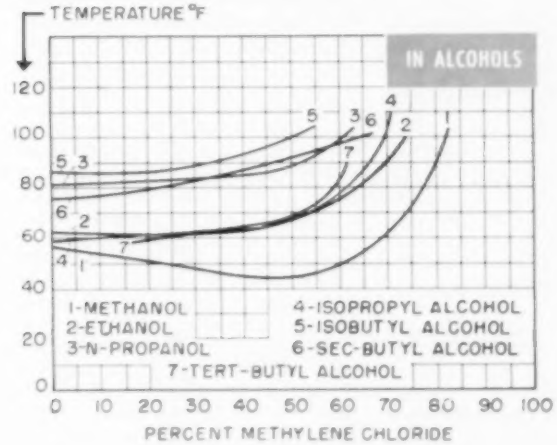
The flash point of a solvent is defined as the lowest temperature at which the application of a flame will cause the vapor at the surface of the liquid to flash but not to burn continuously. By definition a flash consists of a momentary fire that encompasses the entire surface of the liquid in the tester. Any limited, localized burning on the liquid surface is not considered a valid flash. In the case of pure flammable solvents the flash which occurs at the flash point is usually a striking and well defined phenomenon very often accompanied by an audible sound. In the case of mixtures containing a volatile, non-flammable solvent such as methylene chloride the flash point is not so sharply defined. This is due to a particular property of methylene chloride.

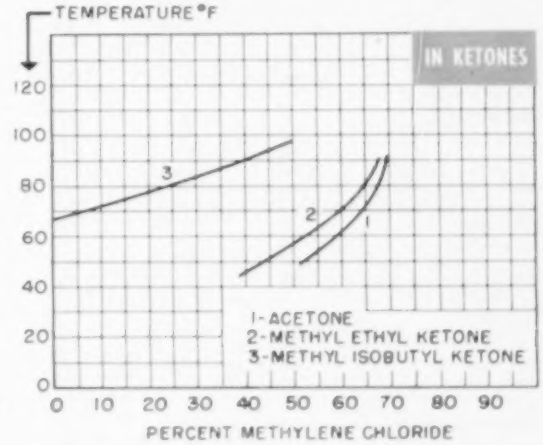
Although methylene chloride will not burn independently, its vapor will burn in the presence of a flame as long as the flame is maintained. When methylene chloride is tested in an open cup tester, a peculiar phenomenon is observed. As the test flame is passed through the region immediately over the surface of the liquid it burns any methylene chloride vapor that comes in contact with it. Consequently a large yellow flame develops about the test burner whenever the latter is in-

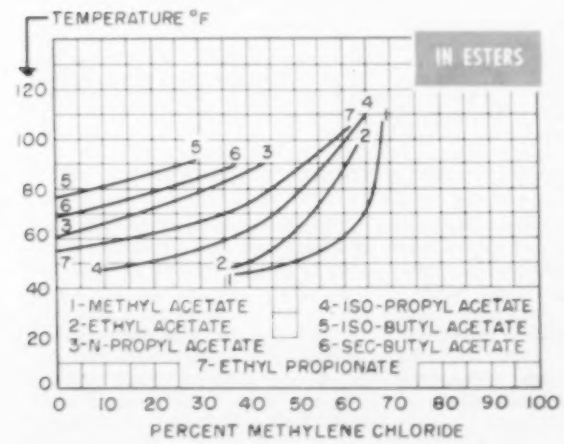
. . . and Its Effect in 27 Solvents











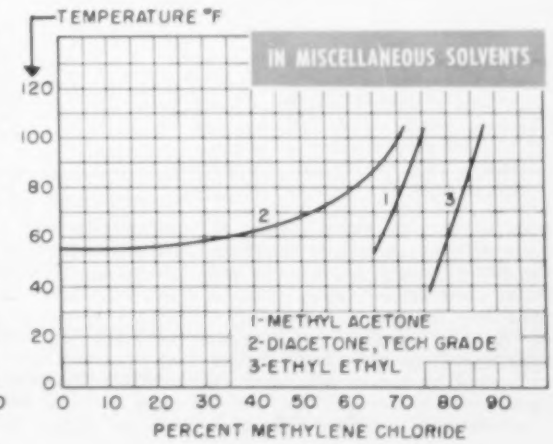


Table 1—Flash and fire points of methylene chloride mixtures

Flammable Co-Solvent	%CH_2Cl_2 in mixture	Flash Point °F.	Fire Point °F.
n-Heptane	40	< 50	64
	60	71.3	93.3
	70	>110*	>110*
n-Octane	40	54.7	80
	50	60.7	92.7
	60	84.7	>110*
VM & P Naphtha	0	59	60
	20	62	77
	40	75.3	98
	50	86	110
Petroleum Ether	60	< 40	< 40
	80	< 40	< 40
	90	< 40	>110*
Cyclohexane	70	48.7	>110*
	80	>110*	>110*
Benzene	60	57.3	>110
	70	>110*	>110*
Toluene	0	50	50
	20	68.5	96
	40	86	>110*
Methanol	0	56.7	56.7
	20	51	51
	40	45	45
	60	50	51.3
	70	63	72
	80	93.3	>110*
Ethanol	0	62	62
	20	61.3	61.3
	40	63	63
	60	76	77.3
	70	91	96
n-Propanol	0	80.7	80.7
	20	83	83
	40	85	85
	60	99	99
iso-Propanol	0	59	59
	20	60.7	60.7
	40	63	69
	60	78.7	90.7
	70	106	>110*
iso-Butyl Alcohol	0	85.3	85.3
	20	86	86
	40	93.3	93.3
	50	98	100
sec-Butyl Alcohol	0	75.3	75.3
	20	79.3	79.3
	40	87.3	87.3
	60	97.3	101.3
Ethyl Ether	60	< 40	< 40
	80	55.3	>110
	90	<110*	>110*
Acetone	60	44.7	62
	70	>110*	>110*
Methyl Ethyl Ketone	40	45	45
	60	70.7	84.7
	70	>110*	>110*
Diacetone, (Tech.)	0	55.3	55.3
	20	56	56
	40	62	64
	60	78	83.3
	70	98	103.3
Methyl Acetone	60	< 50	< 50
	70	73.3	>110*
	80	>110*	>110*
Methyl Isobutyl Ketone	0	66.7	67.3
	20	78	90
	30	84	102.7
Methyl Acetate	40	46	46
	60	60	87.3
	70	>110*	>110*
Ethyl Acetate	40	50	64
	50	63.3	81.3
	60	87.3	>110*
n-Propyl Acetate	0	60	60
	20	72	87.3
	30	78.7	98
	40	86.7	112
iso-Propyl Acetate	0	< 40	< 40
	20	50.7	58
	40	63	86
	50	77.3	117.3
	60	98	
iso-Butyl Acetate	0	76	84.7
	20	86	97.3
sec-Butyl Acetate	0	68	72.7
	20	78	94
	30	84	104
Ethyl Propionate	0	54	54
	20	62	71
	40	73.3	85.3
	50	87.3	109.3
	60	102	>110*

* No attempt was made to determine flash or fire points at temperatures above 110° F. At this temperature, either methylene chloride was rapidly boiling away or the solution was superheated and ready to bump out of the cup.

troduced into the vapor region. At some optimum vapor concentration the flame formed around the test burner may be sufficiently large to reach down to—and cover a small part of—the liquid surface. At no time, however, will the entire liquid surface be covered by a momentary flash of flame.

In mixtures, methylene chloride is generally the lower boiling component and methylene chloride vapor will be present in predominance in the region over the surface of the liquid. Methylene chloride mixtures will behave very much like pure methylene chloride in the open cup tester. Care should be exercised that the mere burning of vapor about the test burner is not interpreted to be a flash point.

The determination of the flash point of a methylene chloride mixture is not quite as straight-forward as is the determination of the flash point of a pure solvent. A little experience is necessary for carrying out this determination properly. It is strongly suggested that the operator acquaint himself with the behavior of pure methylene chloride in the flash point tester before testing

mixtures which contain this solvent. Once a little skill is acquired reproducible results can be obtained continuously without difficulty.

In this study all flash points were determined in duplicate or triplicate. The flash points of all mixtures flashing around 80° F. were determined in triplicate.

Values were accepted only if successive determinations agreed within four degrees. If the discrepancy was greater than four degrees, additional tests were run till at least two successive determinations agreed within four degrees.

Open Versus Closed Cup

Generally methylene chloride forms non-flammable mixtures only with solvents possessing a boiling point equal to or higher than that of methylene chloride. The quantity of methylene chloride required to form a non-flammable solvent mixture is inversely proportional to the boiling point of the flammable solvent. The methylene chloride vapor escaping from the solution dilutes the flammable vapors present above the surface of the liquid. The resultant vapor mixture is less flammable than the pure vapor of the co-solvent. The lower the vapor pressure of the co-solvent, the less methylene chloride vapor is required for dilution purposes. The flash point is a measure of the flammability of the vapor mixture.

The data obtained in this study are similar to those reported by various sources[1] for carbon tetrachloride mixtures. Since methylene chloride is more volatile than carbon tetrachloride one would expect it to tolerate larger quantities of flammable solvent in non-flammable mixtures. This appears to be true. Some comparisons are made in Table 3. This is another advantage that methylene chloride has over carbon tetrachloride. The one obvious shortcoming of methylene chloride is its higher volatility. It will escape from solution somewhat more rapidly than carbon tetrachloride.

Feidler and Meyer[2] and Weinberg and Kunert[3] have reported flash points of some methylene chloride mixtures. Their results were obtained with a closed cup tester and are necessarily different from ours. Flash points of pure solvents determined in the open cup and the closed cup testers often differ by a considerable margin. Mixtures containing methylene chloride yield entirely different results when tested by the two testers.

As pointed out in the section on the determination of flash and fire points, when methylene chloride mixtures are heated, methylene chloride vapors are expelled from the liquid in predominance. In the open cup tester this gives rise to the peculiar phenomenon previously described. In the closed cup tester, these vapors in sufficient concentration will cause extinction of the test flame.

The German investigators chose the extinction phenomenon as their criteria of non-flammability. Mixtures containing sufficient methylene chloride to cause extinction of the test flame in the closed cup tester were considered non-flammable. These investigators determined the composition of such mixtures for 13 solvent systems. All of the mixtures contained less than 50% methylene chloride.

Some work with the closed cup tester was carried out in this laboratory. Results similar to those reported by the Germans were obtained. However, good reproducible results could only be obtained by exercising extreme care in the determination. Work with the open cup tester was much simpler by comparison.

Mixtures which were judged non-flammable in the closed cup tester were found to flash in the open cup at temperatures far below 80° F. This made the interpretation of closed cup results a little difficult. Due to the difficulty of determination and interpretation, and to the fact that the ICC defines flammability ratings in terms of the open cup tester, no further consideration was given to closed cup flash points.

Flash points determined with the open cup tester are a fairly good and safe indication of the temperature at which a solvent may flash in actual practice. However, it should always be borne in mind that methylene chloride constitutes the more volatile component of the mixture. If the mixture be left exposed to the atmosphere for a period of time methylene chloride will evaporate off and the resultant solvent will be flammable.

If the mixture is kept in a closed system, as is the case in dry cleaning and wool degreasing operations, this difficulty will be avoided. The composition of methylene chloride mixtures may be determined from specific gravity or refractive index measurements if the solution is not heavily contaminated with foreign material. Unfortunately, in many degreasing operations the solvent is far too contaminated to permit such analyses. In such circumstances the best indications of flammability will be obtained by determining the flash point of the working solution at reasonable intervals.

With ordinary caution, methylene chloride mixtures can be considered quite safe in any operation.

Table 2—Composition of methylene chloride mixtures which flash at 80° F.

Flammable Co-Solvent	% CH_2Cl_2 in Mixture
n-Heptane	62
n-Octane	59
VM & P Naphtha	45.5
Petroleum Ether (30°—60°)	94
Cyclohexane	75
Benzene	64
Toluene	34
Methanol	77
Ethanol	63.5
iso-Propanol	61
t-Butyl Alcohol	59
s-Butyl Alcohol	22
Ethyl Ether	84
Acetone	67
Methyl Ethyl Ketone	64.5
Diacetone, (Tech.)	61.5
Methyl Acetone	71.5
Methyl Isobutyl Ketone	24
Methyl Acetate	67
Ethyl Acetate	57.5
n-Propyl Acetate	32
i-Propyl Acetate	51.5
i-Butyl Acetate	8.5
s-Butyl Acetate	24
Ethyl Propionate	45.5

Table 3—Flash points of certain chlorinated methane mixtures

Co-solvent	% CCl_4 necessary to prevent flashing at 75° F.(2)	% CH_2Cl_2 necessary to prevent flashing at 75° F.
Benzene	70	63.5
Toluene	35	30
Methanol	85	76
Acetone	85	66.5
Ethyl Acetate	65	56.5

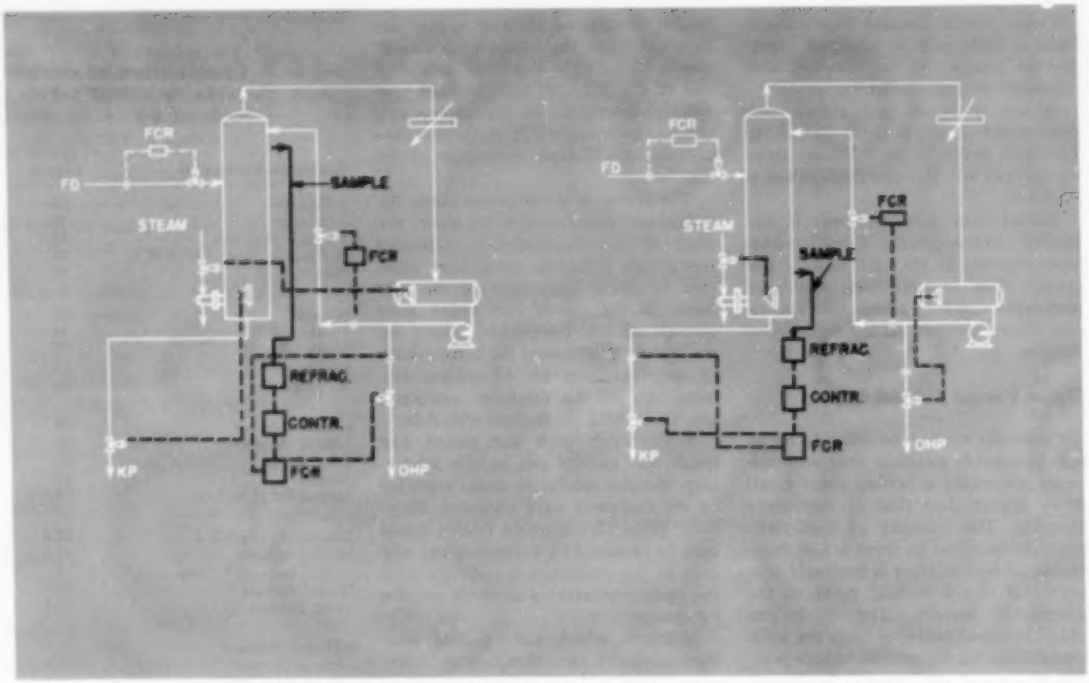
"Soyez les Bienvenus à Montréal au Mois de Mai!"

References

(1) I. Mellan, "Industrial Solvents," Reinhold Publishing Company, New York, 1950, page 207.

(2) Feidler and Meyer, *Paint and Varnish Production Manager*, 27, 267 (1947) and *Farben-Ztg.*, 46, 464 (1941); cf. *Chemical Abstracts*, 39, 4487 (1945).

(3) Weinberg and Kunert, *Fette und Seifen*, 51, 192 (1944); cf. *Chemical Abstracts*, 42, 9179c (1948).



EASY INSTALLATION, whether it's tied in with overhead product (left) or with kettle product (right), one of several reasons why you should . . .

Consider Using the Refractometer

- How it can solve your fractionation control problem
- Specific problems to which it can be applied
- How to choose the right control method
- Maintenance requirements and operator training

By O. D. LARRISON, F. W. PURL, and H. R. HARRIS
Phillips Petroleum Co.*

FOR today's natural gasoline fractionation, or for petrochemical separations, the answer to the problem of precise, continuous, and automatic control may well be in the use of a differential refractometer.

Easy installation, cited above, is only one factor in its favor. Others include:

1—Continuous analytical information, automatically and correctively applied.

2—Reduction of laboratory analyses for control purposes.

3—Ability to maintain a close separation constantly.

4—Improvement of the feed for the next column in a series.

As investigated by Phillips Petroleum Co., who developed the instrument discussed here, a differential refractometer control system can be applied to a number of basic operations:

1—Separating extremely narrow boiling range fractions of pentanes, hexanes, and heptanes in natural gasoline streams.

2—Fractionating light hydrocarbons in the butane boiling range.

3—Several successful separation applications in petrochemical processing.

The way the instrument fits into an operation is illustrated above, showing the signal loop from detector to applier. Note the diagram for a system based on the overhead product. First, the instrument signals a refractive index change in the sample denoting—say—that liquid now being sampled should be lower in the column. The recorder signals an air pressure change to the overhead, rate-of-flow control-

* The authors are with Phillips Petroleum Co., Bartlesville, Okla. This article has been adapted from their paper, "The Differential Refractometer for Automatic Control of Fractionating Columns," presented at the 10th Conference of the Instrument Society of America, Los Angeles, Calif., Sept. 1955.

ler, reducing the volume of overhead product.

This reduction in volume causes the level in the overhead accumulator to rise. The liquid level controller on the accumulator tank measures this change in level and causes the steam (heat) flow to be reduced a proportionate amount. This change in heat input causes correct column operation to be restored, and returns the normal sample mixture to the sample tray. The heat and material balances are then adjusted to maintain a constant composition at the sample point.

The reason for developing the instrument is this. One of the constant physical properties of any liquid, including hydrocarbons, is the refractive index. This phenomenon is additive. A liquid with an index of 1.4 mixed half and half by volume with a liquid whose index is 1.6 would result in a solution with an index of 1.5.

There are characteristic refractive index values for most gasoline streams. To make use of this, the refractive index at the chosen sample point on the fractionator must be correlated with the desired, optimum column product. In most cases that have been studied, the refractive index gradient of the fractionator correlates fairly closely with the composition gradient of the heavy component of the separation.

Several column conditions or functions can usually be correlated with the refractive index of a carefully selected sample point on the column:

1—Initial boiling points and end points.

2—Representative hydrocarbons in the overhead or kettle products.

3—Purity of the principle product stream.

4—The percentage of component being recovered that is lost in the "off" stream.

All of these conditions could exist in the same operation, and frequently do, but to varying degrees. A strong correlation with any *one* of them, however, will serve to monitor the quality of production and make automatic control possible.

General Applications

Because of the demand for better gasoline, the careful separation of the high grade natural gasoline components into individual hydrocarbons has become essential. These "super-fractionated" components are then reblended into the type of gasolines needed.

Such separations demand precise and consistent fractionation. For example, in a normal heptane-toluene separation, it would require very little normal heptane in the toluene to reduce the rich rating considerably. For high volume production, on the other hand, it is necessary to lose some of the toluene to remove the normal heptane. This loss is undesirable and should be held to a minimum. Another example is the separation of cyclohexane and methylcyclopentane. Some loss of cyclohexane is inevitable. Yet a good clean precise operation will hold the loss to minimum and tolerable proportions.

With few exceptions, the refractive index of samples taken at several trays of a column will reveal that the overhead product has a lower index value than the kettle product. The gradient between the two is in various shapes and forms. Fig. 1 has a normal refractive index gradient in Curve A.

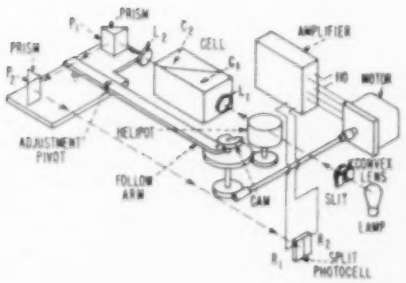
The very fact that at some point on this gradient there is a linear but changing portion is what makes fractionators particularly adaptable to control by refractometer.

The few columns separating liquid hydrocarbons which have no difference in refractive index between kettle and overhead are impossible to control by this technique. Curve B in Fig. 1 is typical of these separations.

Specific Applications

How do you know whether this control method will work? If a potential application fits into one of the categories listed above, a refractive index survey of the column is made. Samples from several trays are analyzed for refractive index. These data are plotted as index versus tray number. The

How the Refractometer Works



● Shown above is an abstracted layout of the refractometer.[1] The source lamp *S*, located at the focal point of lens L_1, furnishes the light that passes through lens L_1, standard cell C_1, sample cell C_2, and lens L_2. The light is then reflected by prisms P_1 and P_2 to fall on the two photocells R_1 and R_2.

In this position, there is an equal amount of light falling on both photocells, and a null condition exists in the servo-mechanism. If, however, the sample refractive index changes, the light image is refracted so that it will fall on one or the other of the photocells. The servo system, thus unbalanced, will act on the photocell signal to rebalance itself.

The photocell signal is amplified, driving the motor and the cam to reposition the light image so that it is again equally divided on the two photocells. A telemetering system is used which includes a helipot linked mechanically to the cam and varying in resistance with rotation of the cam.

This resistance determines the voltage which drives the conventional electronic recorder. The recorder is the transducer of the electrical-to-air signal which is finally used to adjust the process control element.

At one point, the sample and the standard solutions are separated only by an impermeable diaphragm, acting as the pressure equalizer. Sample temperature is maintained near the standard temperature by coiling the sample line through a tank of water and glycol solution.

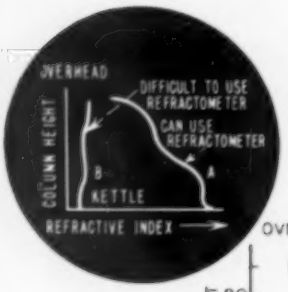


FIG. 1 — How the refractive index gradient permits use of refractometer for refractionator control

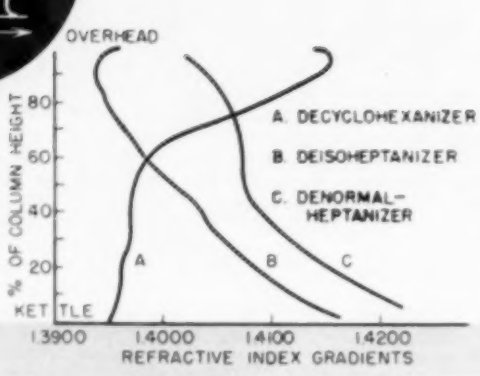


FIG. 2—Refractive index gradients of some presently existing applications

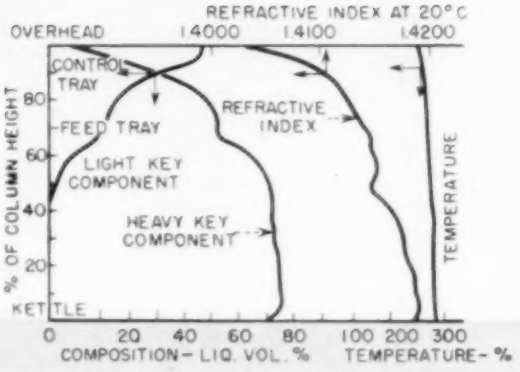


FIG. 3—Specific data on a separation of methylcyclopentane and cyclohexane

region where there is maximum index change from one tray to the next is chosen for the tentative sampling area.

The refractive index gradients of some of the present services are shown in Fig. 2. Index is plotted against % of column height at which the sample was taken; i.e., the 25th tray of a 50-tray column would be 50%.

The very smallest usable refractive index change from one tray to the next in the sample region is 0.00001 unit. It is better to have considerably more than this. But under optimum conditions, the instrument has the sensitivity to utilize that infinitesimal change.

If these two conditions are met—liquid sample and sufficient refractive index change—then the refractometer will probably be able to control the column.

The next step is construction of a sampling system. A by-pass system is used with a line from the sample passing close to the refractometer and then re-entering the system. The point of re-entry must be so chosen that the sample will not cause contamination. The actual refractometer sample is then taken off through small tubing from the sample line as it passes near the instrument. Sample volume is about 5 to 15 cc./min.

Recording of refractive index changes occurring on the sample tray can then be started. All available data is accumulated to find the analytical method and the property of the column that varies along with the refractive index at the sample tray.

Fig. 3 shows some data on a methylcyclopentane-cyclohexane separation. The heavy key component in the overhead has been plotted to show its composition gradient. The refractive index gradient was drawn with it for comparison purposes. The light key component and the temperature gradient were plotted on the same chart with scales chosen to represent the relative sensitivities of the detection instruments.

It can be seen that the refractive index gradient has much more slope than the temperature gradient. In this case, the illustrated separation is fractionating methylcyclopentane as the overhead product—hence the column is called a demethylcyclopentanizer. The temperature and refractive index gradients were plotted on scales showing the entire range of their controlling ability.

From the gradients, which should show comparative sensitivity to column fluctuations, it can be readily observed that refractive index would be the better controlling agent.

To verify this conclusion, one needs only to show that the concentration of the heavy key component in the overhead varies in proportion to the refractive index of the control tray. To learn whether or not this is true, several dozen samples are analyzed and the analyses plotted against the refractometer readings taken at the time each of the samples was drawn.

Two examples of such a correlation are shown in Fig. 4. Curve A in this figure shows the same demethylcyclopentanizer under discussion. As can be observed by this curve, the refractometer is indirectly, but accurately, indicating the percent of the controlling heavy key component in the overhead product of this column.

There is now acceptable data to show that the percentage of this key component can be predicted by only observing the refractometer reading. It must follow, then, that if the refractometer can automatically vary the heat input to the column so that the refractive index on the sample tray remains very nearly constant, the significant overhead component will remain very nearly constant.

The manner in which the refractometer reading is harnessed to the steam will be discussed later. For now, assume that it can be done. The only remaining task is to choose the separation that the column should make and allow the refractometer to maintain it.

Still considering the demethylcyclopentanizer, it was decided that a steady 5 to 7% of the heavy key component in the overhead would make a finer cut than had heretofore been possible or feasible. From the chart, it can be seen that to do this, it is only necessary that the refractometer reading be held between 60 and 70% of its range. If better control could be realized and the refractometer vary less than 10% of its range, that would be even better.

Curve B in Fig. 4 shows the same type correlation on a catalytic reformate splitter. Here, it was found that the refractometer reading correlated very well with the total amount of toluene lost overhead in a paraffin-aromatic

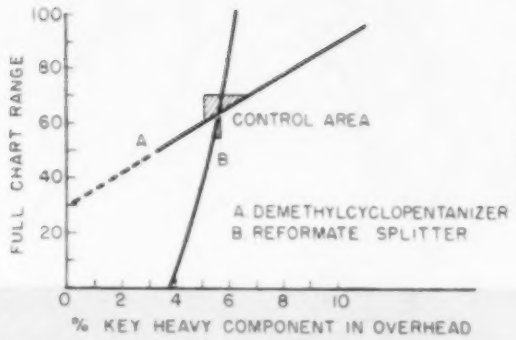


FIG. 4—Finding control area by correlating chart range with key heavy component in overhead

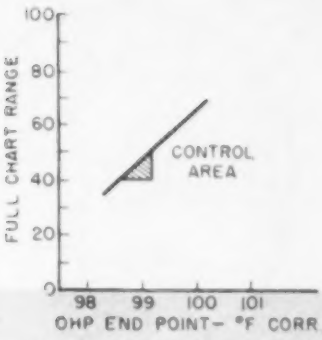


Fig. 5—Determining control area by correlating chart range with end point of overhead product

separation. It was determined that this separation could be controlled to within ±0.15% toluene in the overhead.

In other words, the desired percentage of toluene lost overhead could be maintained to within ±0.15% merely by holding the refractometer between 55 and 65% of its total range.

Fig. 5 shows a correlation between the refractometer reading and the end point of a weathering test run on a denormalpentanizer overhead product. Note that the actual control range of 40 to 50% of the refractometer scale will hold the end point within ±0.3° F. Weathering tests are run every two hours on some processes to check the quality of the separation.

Picture the incurred savings in sampling and analyzing. The refractometer can accurately indicate the results before a sample is run; and, if necessary, correctively apply its answers. The only sampling necessary is an infrequent check on the refractometer. With the instrument doing its job correctly, an operator can observe its reading and confidently predict the test value for a given refractometer reading.

What jobs are being done in actual service by a refractometer?

In Fig. 6, the demethylcyclopentanizer is again illustrated. The left figure in the picture shows a typical chart with the column on manual rate-of-flow control. The chart covers a 24-hr. period.

Note that with the instrument only recording, the refractive index varied over at least 65% of full chart range —actually, there is no way of knowing how far past 100% of its scale it would have gone if it had been able to record in that range. Assuming that the instrument would have gone no farther than 100% of its scale, there would have been a variation of from 3.0 to at least 10% of the controlling heavy key component in the overhead product.

The fact is, however, that the analyses on that day of non-control showed that the cyclohexane in the overhead product varied from about 3.0 to 21.0%, which is considerable variation.

The chart showing "on-control," however, varied only from 63 to 70% of full scale, or only 7%. This is roughly one-ninth as much variation as was experienced on the "off-control" day.

The variation of the cyclohexane in the overhead product was 1.6% total deviation. This is one-eleventh as much variation as was experienced on the "off-control" day. It is significant also that for a temperature controller to keep the column running as consistently as on the control day, it would have to maintain the tray temperature to ±0.7° F. This assumes that a temperature controller could in any way be correlated with the desired operating conditions of the column.

Some of the other separations that are being controlled by the differential refractometer are shown in Fig. 7. These illustrate the versatility of the instrument. A denormalhexanizer, catalytic reformate splitter, and a denormalpentanizer are shown. The denormalhexanizer separates normal hexane from methylcyclopentane and cyclohexane; hence, it is a paraffin-naphthene separation. The reformate splitter separates normal heptane from toluene and some xylenes; hence, it is a paraffin-aromatic separation. The denormalpentanizer separates normal pentane from cyclopentane; hence, it is a paraffin-naphthene separation. The illustrations that have been shown run the gamut of column services from pentanes to xylenes.

Choosing the Method

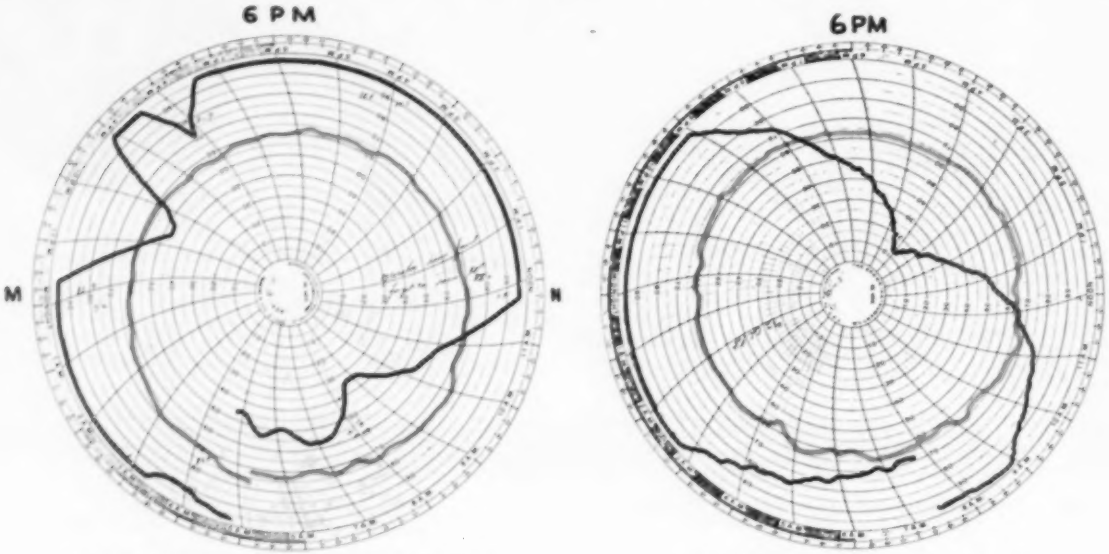
The differential refractometer has been applied to its controlling task in several slightly different ways. In all, it has been used ultimately to control the heat input to the fractionator.

The difference is in the route of the signal to the steam motor valve. Some of the considerations encountered in choosing the method of applying the refractometer are: position in the column of the sampling area, ratio of the feed volume to kettle and overhead product volumes, and the product stream in which a key component is controlled. Others of minor consideration are cooling capacity, previous control method, and operator's training. These considerations are all factors involved in the choice of control method.

Overhead product method: the refractometer correctively varies the overhead product take-off volume re-

Actual Service Charts Show Closer Control by Refractometer

Color line is "on" control
Black line is "off" control



DEMETHYLCYCLOPENTANIZER **DENORMAL HEXANIZER**

sulting in an overhead accumulator level change which adjusts the steam. This is shown at the left in the drawing on p. 1750.

The signal chain is: Detector (refractometer) to transducer (recorder) to flow controller (overhead rate-of-flow controller) to steam controller (the overhead accumulator level) to steam motor valve (heat input) to sample and finally to detector again.

This type of control is usually used if these general conditions exist:

1—When less than 90% of the feed is going into the overhead product.

2—When the concentration of a key component in the overhead product is controlled.

3—When the previous control system employed rate of flow control of the overhead product. This saves the expense of additional instrumentation.

Kettle product method: this differs from the overhead method only in that the kettle product rate-of-flow controller and the kettle level are used to vary the steam.

The signal chain as shown at the right in the drawing on p. 1750 is: Detector (refractometer) to transducer (recorder) to kettle product rate-of-flow controller to steam controller (kettle level) to steam motor valve (heat input) to sample to detector.

This type of control system is generally used when these conditions exist:

1—When less than 90% of the feed is kettle product.

2—When the concentration of a key component in the kettle product is controlled.

3—When the previous control system employed rate-of-flow control of the kettle product.

These two control types are the ones commonly used. They make use of an instrumentation principle known as "cascading." That is the indirect routing of the signal from detector to the process variant. This system is harder to upset than the more direct methods and the upsets are less violent. The cascade acts as a dampener.

There are other control systems that have been employed with the refractometer to lesser extent—the column pressure drop method, the reflux method, and the direct steam control method. All these make use of the cascade principle except the direct method.

The major difference between these methods and the kettle and overhead methods is the agent used to control the steam. As may be surmised, the direct steam control method controls the steam directly from the refractometer recorder. The reflux method uses the liquid level of the reflux accumulator, and the pressure drop method uses the column differential pressure drop by varying the reflux volume.

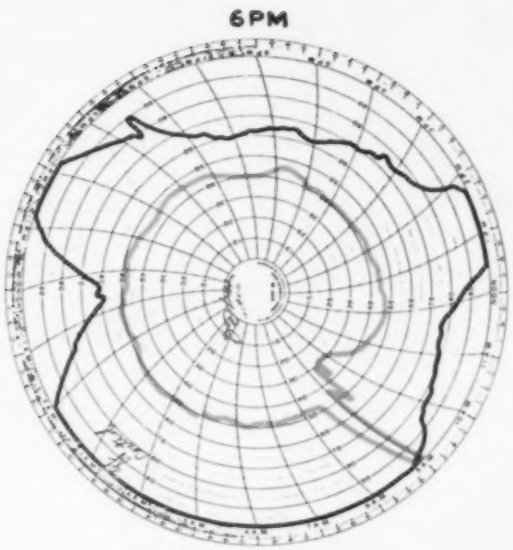
As a general rule, these methods are never used unless the first two methods prove impossible to apply. If this is the case, a careful study is made to ascertain the most suitable of the less frequently used controls.

Expense of the installation is often one of the prime considerations. In this category, the direct method is often thought of as best. But due to upsets, it is rarely more economical in the long run.

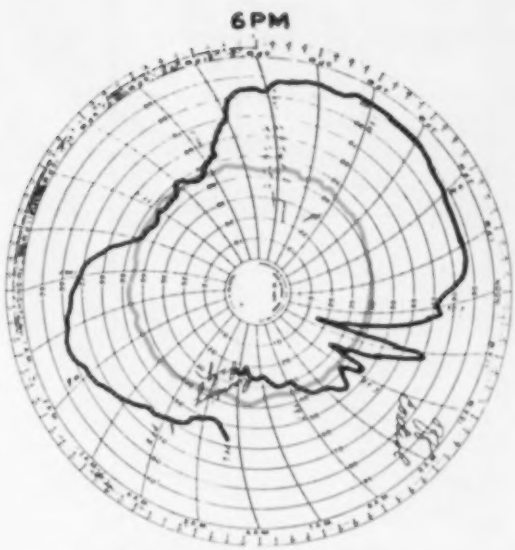
Training and Maintenance

The problem of applying the instrument can be considerably simplified by giving the fractionator operator the opportunity to learn about the instrument as quickly as possible. He should receive instructions in every phase of the instrument so that he fully understands its usefulness and its limitations and how it will enhance rather than impair his position. He should learn to recognize malfunctions as opposed to correct, but abnormal, deviations. The instrument man and the operator, working together, can be far more successful than either alone could hope to be.

Calibration charts showing desired operating performance should be available. A working knowledge of the instruments, component parts and the manner in which the instrument performs its tasks should be made clear to him. The operator should know the instrument's normal limitations; that is, at what point it should be taken off control and at what point it should be returned to automatic operation. There should be available graphs and charts showing the correlation of the refractometer indicator reading and the process quality-indicating component. He should know when to call for



REFORMATE SPLITTER



DENORMAL PENTANIZER

maintenance men. The entire control system and technique should be outlined for his benefit with reasons and explanations accompanying the outline.

The maintenance is for the most part routine and preventive. There, of course, remain quite a few malfunctions of electronic apparatus that are far from routine. There also remains the problem of separating instrument malfunction from abnormal process variation.

These two deviations from routine maintenance plus the problem of applying the instrument have resulted in a separate maintenance-application group. They are responsible for the correct operation of about ten refractometer installations as well as partial responsibility for some other automatic analyzers used in the area. They assume problems of correlation, installation, and integration with existing controls. They make available desired information to process operators, and they do all the routine and preventive maintenance required by the instruments. They, of necessity, become intimately familiar with the operating and production problems and principals of each process or separation. They take and interpret as much analytical data as is possible and work with process engineers in selecting and developing new applications.

Two technical men, one full time and one part time, work with the refractometers with the greater part of their time spent in expanding the application of this new control method.

Preventive maintenance: There are electronic failures such as tubes, source lamps, and photocells that regularly occur. The regularity can be established, so that it is possible periodically or conveniently to replace components that would probably expire shortly. With such a schedule, there are far fewer chances of surprise instrument failures which can cause serious column upsets. Following is a list of some of the things that can be done by schedule:

1—Oiling, according to oiling chart.
2—Cleaning slidewire.
3—Cleaning sample filters.
4—Replacing source light.
5—Battery changes (in recorder).
6—Tube changes.

Unscheduled maintenance: Repairs on an instrument that has failed in service are done immediately. Some portions of the instrument that occasionally need repair or replacement are: amplification system, sample system, optical system, including the source light, and the telemetering system.

There is only a remote possibility of more than one component of any of these systems going bad at the same time. Therefore, to repair an instrument is usually very simple after the diagnosis has been completed. There are others, however, that are not as simple:

1—Failures of unknown resistors or condensors of the amplifiers or elsewhere in the electrical system. This usually calls for specialized experience in electronics and a versatile use of testing equipment.

2—Incorrect sensitivities in the control system. Occasionally, the controller settings must be readjusted to keep the control system most efficient. Along with experience must come some originality, because no two applications are exactly the same.

Conclusion

The conception and construction of the differential refractometer has resulted in a simple and versatile instrument with great utility. Its special and almost unlimited applicability to gasoline fractionators has been demonstrated by use on natural gasoline and petrochemical separations.

Although applications outside the field of fractionator control work have not been discussed, it should be pointed out that they do exist; for example, reblending of hydrocarbons, mixing of streams for constant feed stock blends, and detection of contaminates in an uncontrollable stream or process.

In conclusion and review, it should be stated that this instrument has versatility, utility and simplicity rarely encountered in automatic instrumentation.

(1) E. C. Miller, F. W. Crawford, and B. J. Simmons "A Differential Refractometer for Process Control," *Analytical Chemistry*, Vol. 24, No. 7, Page 1087, July, 1952.

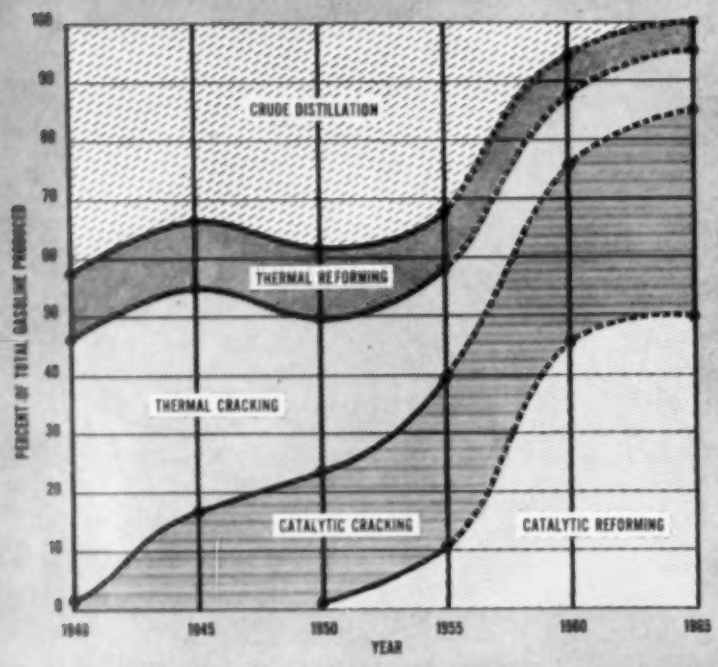


FIG. 1. Trends in processes for making gasoline. By 1965 catalytic reforming may account for 50% of all gasoline.

How to get your top octanes more economically

By HAROLD J. GIBSON
Ethyl Corporation, Detroit, Michigan

WITH the growing trend to better-grade gasolines, the cost of producing those last few octane numbers has steadily increased. As a result, refiners are looking anxiously for more economical ways to get their top octanes.

Already octane numbers in the 97 to 98 range are being marketed in the East and Southwest. And the trends for all U.S. refineries in terms of pool, regular and premium fuels show that octane numbers are continuing a slow, steady rise each year.

To meet the demand for higher-octane fuels, refiners are being constantly forced to change their processes. A look at the graph at the top of the page (Fig.1) will show you the gradual changes in process evolution. Note that by 1965 catalytic reforming may account for 50% of the total gasoline production in the industry.

Depending on the specific octane-improvement problem, the economic answer usually consists of a combination of tetraethyllead and various processing steps. (Some of these processing alternatives are displayed in Fig. 2.) The question becomes: How to determine the most economical way to get those top octanes. Only by conducting a detailed economic analysis can a refiner be sure of finding the best solution for his refinery, for from an economic analysis he can determine the proper balance between lead and a processing alternative.

An economic analysis will take into consideration all of the factors that affect the costs of making your gasoline: for example, optimum rates and yields, raw-material costs, product prices, operating manpower, maintenance and repair, utilities, depreciation, investment charges and reasonable "pay out."

TABLE I. Estimated Pool Octanes and Premium — Regular Octane Numbers

		With 2.2 ml gal TETRAETHYLLEAD	With 3.0 ml gal TETRAETHYLLEAD
At the end of 1953	Pool	88.0	89.4
	Premium	92.9	94.3
	Regular	85.9	87.3
At the end of 1954	Pool	89.3	90.7
	Premium	94.2	95.6
	Regular	87.2	88.6
At the end of 1955	Pool	90.8	92.1
	Premium	95.7	97.0
	Regular	88.7	90.0

Octane improvement analyzed

From such an analysis you can determine the economics of octane improvement, which is the tool for obtaining the optimum sequence of processing steps and attendant use of tetraethyllead. Analyzing octane improvement costs calls for a thorough understanding of unit operating costs, particularly when incremental expenses are being considered.

There are several approaches for analyzing the costs of octane improvement at higher levels. At Ethyl we have found, through our studies of the economics of top octanes, that the key to cost analysis is a value called *incremental cost*. Simply expressed, this is the rate at which costs increase as you raise the octane number. It can be expressed conven-

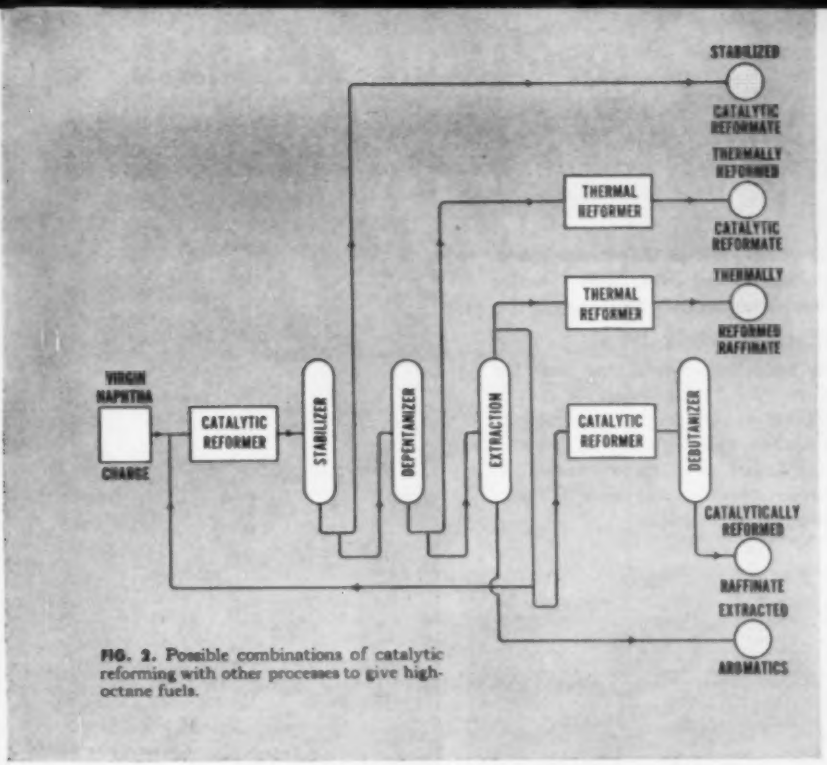


FIG. 2. Possible combinations of catalytic reforming with other processes to give high-octane fuels.

iently in cents per Research octane number per barrel. (¢/RONB).

Once you determine incremental costs, the next step is to make sure you are employing the best possible process at each point. By plotting the cost curves on a chart, you will see that up to a point the cheapest way to improve gasoline is with lead. Then lead becomes closely competitive with mild reforming methods.

After you reach an incremental cost of about 5¢/RONB, it again is definitely cheaper to add tetraethyllead. And finally when the full 3 cc of lead is used, you must return to reforming—this time at greater severity.

Today there's a greater trend toward using lead in higher concentrations for, as one industry spokesman put it, "tetraethyllead has decreased steadily in price while the costs of refinery construction have continued to rise rather sharply."

With constantly increasing gasoline-quality demands facing the refiner, it has become increasingly important to define the optimum route to high-octane fuels. Lead addition now costs an average of 4 to 5 cents per Research octane number per barrel, and this is directly competitive with the cost of mild reforming operations for octane improvement. As product octane levels increase, refiners may have the choice of using maximum tetraethyllead—3 ml/gal—or going to more expensive reforming operations—more severe single pass reforming or extraction followed by raffinate reforming. Here—even though lead susceptibility decreases somewhat in aromatic reformates—the cost of octane improvement by lead becomes increasingly more attractive as compared with various processing alternatives. Where extremely high octane levels are required, a refiner has little choice but to use the more economic tetraethyllead to the maximum and then to vary his processing alternatives to give the desired product quality if he wants to hold his manufacturing costs to a minimum.

KNOW THIS EQUATION?

$$¢/RONB = \frac{(Y-100-F)(Pg-9.4T) + Pb(F+G) + Pf100H - 100E}{100\,RONp - 100\,RONn - 10F + Y(RONr - RONp)}$$

You should if you are making an economic analysis. Write for a copy of a recent 50-page report giving a definition of terms of this equation and other information on new processing alternatives and on the economics of top octanes. Address your request to Department No. 13, Ethyl Corporation, 100 Park Avenue, New York, New York. No charge.

HOW Ethyl Research can help you

Our Refinery Technology staff, backed up by the extensive facilities of the Ethyl Laboratories, will be glad to share their experience with your economics people when you conduct a cost analysis of your top octanes.

We will work with you, or if you prefer, we are even equipped to do a complete cost analysis for you.

We can help you answer these and other questions: When should you use "Ethyl" antiknock compound in preference to increasing the catalytic reformer charge rate? How does increased severity of reforming affect your costs? When should you carry your tetraethyllead content to the maximum allowable—and under what circumstances?

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Vapor Phase Chromatography is a recently perfected powerful new analytical technique, first disclosed by Dr. A. J. P. Martin, Nobel Prize Winner, in 1941. It requires small samples (3 gas cc.), is rapid, (15 to 40 mins.), is applicable to primary analysis of many mixtures where its accuracy (ranging from 1% to 4% of component) is adequate. It is a logical supplement to distillation methods in resolving fractions not separable by distillation alone. In most cases its results equal or surpass those obtained from spectrographic techniques.

PODBIELNIAK OFFERS THE BEST AVAILABLE ANALYTICAL AND RESEARCH TOOLS
Using the Principles of Fractional Distillation and Vapor Phase Chromatography, Separately or in Most Effective Combination.

THERMOCON
Automatic Recording Low-Temperature Analytical Distillation Apparatus with Coupled CHROMACON.

HYPER-CAL
Automatic Recording High-Temperature Laboratory Distillation Apparatus with Coupled CHROMACON.

Other combination models available.

APPLICATIONS

For Primary Analysis: The CHROMACON, whether separate or combined, may be used for the rapid analysis of a great many mixtures, within the scope and limitations of the vapor phase chromatography method. Write for detailed information.

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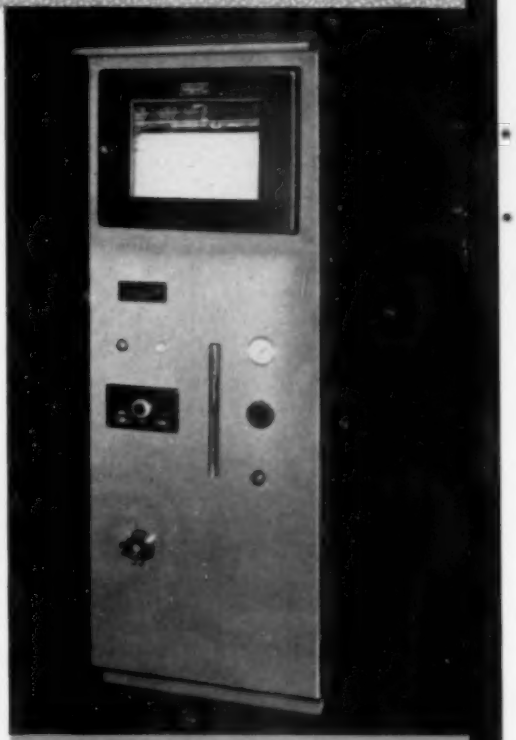

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Vapor Phase Chromatograph Apparatus
Separately Mounted

The CHROMACON is designed according to the latest advances in this analytical technique, and with the benefit of 25 years of experience by Podbielniak in the field of distillation, adsorbent and solvent separations.

The CHROMACON comprises: three stainless steel chromatographic columns, with compression metal couplings, a special, high-sensitivity, low-holdup thermistor type thermal conductivity cell detector and circuits; a fluid-damped precision pressure regulator and needle valve to control flow of carrier gas; sampling section; an electrically heated thermostatted enclosure (to 160°C.) around the columns and detector cell; all necessary connections, gages, controls, etc. The special electronic recorder, as illustrated, has 1 sec. full scale pen travel, 1 mv. range, rapid chart travel.

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Your Guide to . . .
Petroleum Processing

IT'S NEW

Your "Clip-n-File" Process Data Sheet

A new feature this month—and every month from now on—this three-page, fold-out data sheet has been designed for your convenience. It is perforated—so you can remove it quickly and neatly. Use it to build up your own personal process manual. This month's subject is:

Ethylene Oxide by Direct Air Oxidation of Ethylene

. . . a process aimed at high product purity, good product yields at low operating cost and low raw materials costs. **p. 1765**

Cut Condenser Tube Failures

Here's a technique Socony Mobil Oil Co. men worked out at the East Chicago refinery to solve this annoying problem, along with four other helpful Plant Practices. **p. 1769**

Jet Engine Fuels

Patents of this month cover methods for improving the viscosity index of jet fuels by using oil-soluble, high molecular weight additives. Results: better combustion efficiencies. (Patents) **p. 1785**

Many Meetings this Fall

Check on your favorite technical society's current activities. Annual conferences of many important groups take place in the coming winter months. Find out what's being planned. (Meetings) **p. 1793**

Departments

New Data on Project 37

. . . is available in a monograph by Bruce H. Sage and William N. Lacey, covering API Research Project 37 on the lighter hydrocarbons, hydrogen sulfide, and carbon dioxide. Reviewed in this month's Books. **p. 1797**

New Ultrasonic Flowmeter

. . . for use measuring either mass or volume, with capacities ranging up to 12,000 lb/min., and an accuracy of better than 2% of full scale, plus over 50 other new ideas in equipment, supplies, and helpful information. (What's New) **p. 1801**

Glad You're an Oil Man?

The petroleum industry is a "good place to work." Most of us wouldn't trade our jobs fast. Here's an editorial pointing out some of the more important reasons why. (Editorials) **p. 1832**

INDEX TO ALL DEPARTMENTS

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. . . and all the fixin's—thanks to BRICK

On the table at last, after hours of tantalizing fragrances wafting from the kitchen. Another mission completed by brick.

Brick built the ships and trains and trucks that brought the "makin's". Refractory brick. It created the steel for the stove and the carving knife . . . the heat for the oven. For everything that's made or moved owes its existence to the refractory brick which contain the flames of industry.

Making these refractories is an exacting science. When you deal with temperatures of thousands of degrees, you can't afford to guess. So General Refractories operates the world's largest and most modern refractories research laboratory, constantly seeking progress and perfection.

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GENERAL REFRACTORIES COMPANY
Philadelphia 2

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LITECAST 50—A hydraulic-setting insulating castable refractory material, having a density of approximately 50 lbs. per cubic foot. Its extreme light weight and exceptionally low thermal conductivity make it an efficient and economical heat insulator. Recommended for vessel linings and backing for brickwork for other heavier castable refractory materials.

HIGH-STRENGTH BRIK-CAST—A hydraulic-setting castable refractory material unique in that it contains more bonding agent, which results in a product more resistant to the physical actions of impact, erosion, and load bearing. Used extensively for lining regenerator chambers and catalyst lines in catalytic cracking units.

LITECAST 50-M—A 50-pound density insulating castable, having a high degree of purity, used as a liner in vessels and lines where atmospheres must be controlled, or contamination of internals must be avoided. LITECAST 50-M may be applied in the same manner as standard hydraulic-setting castables.

BRIK-CAST 3000—A hydraulic-setting castable refractory material, composed of clays and bonding agents having the highest purity, resulting in a product with a high operating temperature (3000° F.), and resistance to reducing atmosphere in carbon monoxide attack. Recommended for sulphur burner chambers and other vessels operating above normal cracking and reforming temperatures.

Phenol at 350° F.
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THE CASE HISTORY—Refinery men know that handling hot phenol can be rough on valves and cause a lot of headaches. Or it can be a smooth, efficient valve operation—year in and out—as experienced here at the Continental Oil plant at Ponca City.

These Crane No. 47X 150-pound cast steel gate valves are on phenol service at 60 psi., 350° F. They're on the exhaust line from extraction tower bottoms pump in the aromatic extraction unit.

Installed in 1944, these Crane valves have required only routine maintenance. Operated about twice a month—they continue to make tight closure with ease—with no leakage or sticking.

Outwardly Crane valves may look like many others. But it's a mistake to assume all steel gate valves are alike. The difference that's most important to you is inside—for instance, in the extra skill and care that goes into Crane seating design and materials. That's what makes Crane valves such outstanding performers on refinery service.

You can get Crane quality steel valves for every refinery need—gates, globes, angles and checks—with screwed, flanged or welding ends—in sizes up to 24 in.—in pressure classes up to 2500 psi. See your Crane Representative for valuable help in specifying and ordering. Crane Co., General Offices: Chicago 5, Illinois, Branches and Wholesalers in all areas.

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CRANE'S FIRST CENTURY...1855-1955

Process—Direct production of ethylene oxide
oxidation of ethylene over a fixed-bed, silver-co
taining catalyst.

Process Flow—Ethylene is catalytically oxidiz
to ethylene oxide in an exothermic reaction usi
air or oxygen, after which the oxide is absorbed
a simple scrubbing system followed by distillati
and purification.

Referring to the flow diagram, ethylene, air a
recycle gas are mixed and fed to a multitubul
catalytic reactor. Reactor temperature is clos
controlled by an organic cooling medium. React
effluent gases — containing ethylene oxide — a
cooled and scrubbed with water. Scrubber ov
head gases are mostly recycled to the reactor, w
the remainder of the gases being diverted to
secondary reaction system where operating co
ditions are adjusted to convert the remaini
ethylene. Gas from the secondary reactor is cool
and scrubbed, then purged to the atmosphere.

The dilute ethylene oxide solution from the tw
scrubbers is stripped of its oxide content by hea
ing. Stripper overhead gases are partially co
densed to enrich the gas mixture in ethylene oxi
and deplete it of water vapor. The resulting cru
oxide vapor is compressed and refined in a co
ventional distillation train.

Auxiliary equipment—such as a purge g
scrubber or a product cooler—may be of econom
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and other heavier liquids in a refining column.

Pure ethylene oxide product is pumped as
liquid to storage tanks which are blanketed wi
inert gas.

Raw Materials—Ethylene and air are the on
important raw materials. The ethylene must
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required for the manufacture of polyethylene.

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studies show that unless the oxygen is free, the u
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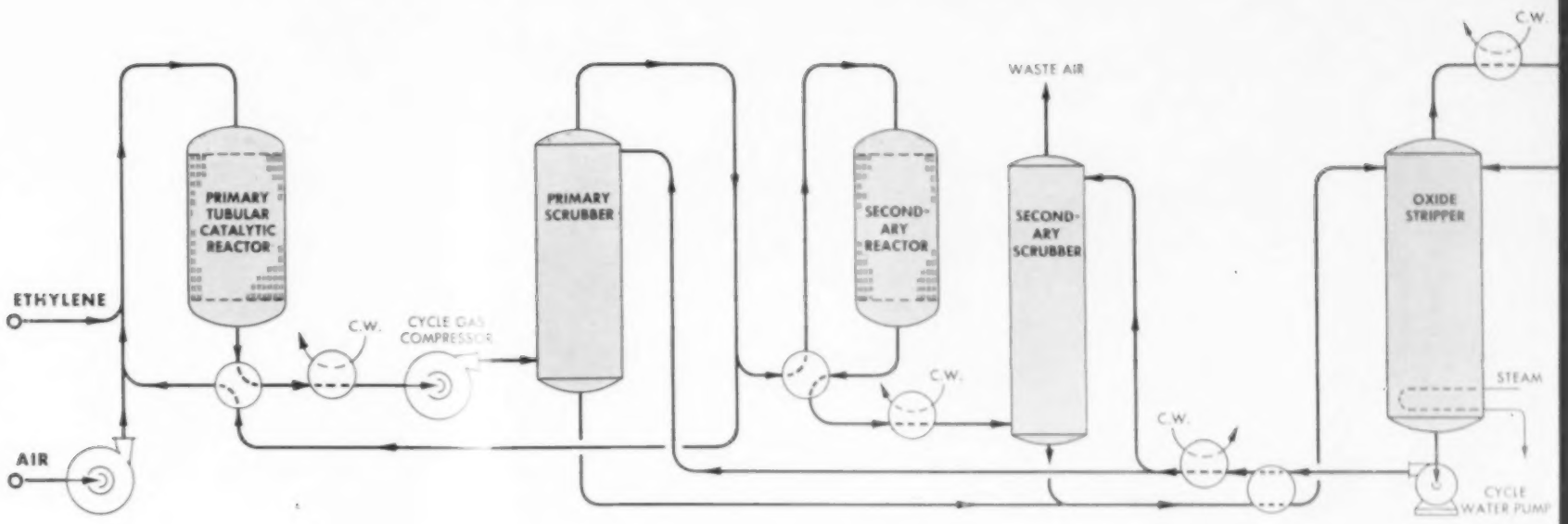
cannot be realized in practice because of the ne
for low oxygen concentrations in the recycle gas
to avoid explosion hazards.

Catalyst—A fixed-bed catalyst which contai
silver as its principal active ingredient is used. Th
fact that silver could be used as a catalyst w
originally discovered in 1930 and patented b
Lefort in France. Catalyst durability and long li



eliminate the need for regeneration during normal operation. Therefore, there is little advantage to the use of fluidized catalyst beds or spare "swing" reactors.

Operating Conditions—Reactor temperatures are usually 425-625° F. and pressures may be 120-300 psig. The recycle gas-oxygen-ethylene mixture must be maintained below the explosive limit. Distillation conditions are usually determined by the available cooling water temperature.

Process Variables—Primary variables controlling catalyst selectivity and conversion are concentrations of ethylene, other hydrocarbons, oxygen and carbon dioxide; flow rates; pressure; temperature; etc. Other important factors—such as catalyst composition, reactor bed type and height, and materials of construction—are designed and built into the plant. With proper reactor design, catalyst selectivity is relatively independent of temperature within certain ranges. Also, as is typical of such vapor-phase oxidations, selectivities are higher at lower conversions per pass—one reason why recycle operation is advantageous.

Product—The overall plant yield of ethylene oxide is normally about 60-65 mol% of theoretical, though higher yields are possible under special conditions. Normally, ethylene oxide produced may be expected to be in the range of one pound per pound of raw ethylene.

The only by-products of the reaction are carbon dioxide and water, which are easily removed. Reaction conditions are such that other intermediate reaction products, if formed—such as acetaldehyde—are immediately oxidized to carbon dioxide and water. A small amount of ethylene glycol is formed as a by-product of the refining system.

Purified ethylene oxide product analyzes 99.5% oxide, meeting all the commercial requirements. Less than 1% of the crude oxide is lost in the recovery of refined oxide from the reaction gases.

Equipment—Due to the pressure, temperature and heat transfer requirements of the catalytic reactors, specialized design techniques have been developed to overcome problems such as thermal expansion.

Proper selection of various alloys for certain items of equipment removes the threat of corrosion. The process is not very corrosive at any rate, and plants built to date have experienced no serious problems in this regard. In the case of the alternative chlorhydrin process,* as is well known, non-metallic materials of construction are required due to the extreme corrosivity of the reactants, intermediates and by-products such as aqueous hydrochloric acid.

Utilities—The reactors yield heat, which is ultimately converted into high pressure steam which can be used to drive turbines—in which case the steam is often superheated in a separately fired heater. Process heat requirements may be met mostly with steam at low pressure, and some with turbine exhaust at pressures below atmospheric.

The process air compressor may be driven by steam turbine, gas turbine or diesel engine. A steam turbine-driven recycle gas compressor may be used to circulate the large volume of cycle gas, though in certain circumstances other drives may be employed.

* The chlorhydrin process is older than the direct oxidation process, but is still in extensive use. The chlorhydrin process involves the indirect oxidation of ethylene with chlorine to produce ethylene chlorhydrin which is then saponified to ethylene oxide. Chlorhydrin process yields are usually around 75%, which are higher than by direct oxidation. However the chorhydrin process requires over 2 lb. of chlorine and 2 lb. of lime per lb. of ethylene oxide produced.

Economics—Investment costs for plants (within the battery limits) would be below 10 cents/lb. of ethylene oxide produced, even for plants with less than 40,000,000 lb./yr. capacities. The cost of the reactors in a typical plant would be less than 10% of the capital investment.

Power costs generally account for less than 10% of production costs, which in turn are estimated to be 25% less than for the older chlorhydrin process for making ethylene oxide.

Many chemical and mechanical variations of the basic design are feasible. Local factors—such as relative costs of steam, fuel, electric power, etc.—strongly influence the optimum economic design.

Installations—Three plants have been built utilizing the Scientific Design Co. process, of which two are currently in operation. Naphtachimie operates a plant at Lavera, France. Nitrogen Div. of Allied Chemical and Dye Corp. operates a plant at Orange, Texas. The Societe Chimique des Derives du Petrole is now completing construction of a plant in Belgium.

Licensor—Scientific Design Co., Inc., 2 Park Ave., New York 16, N.Y.

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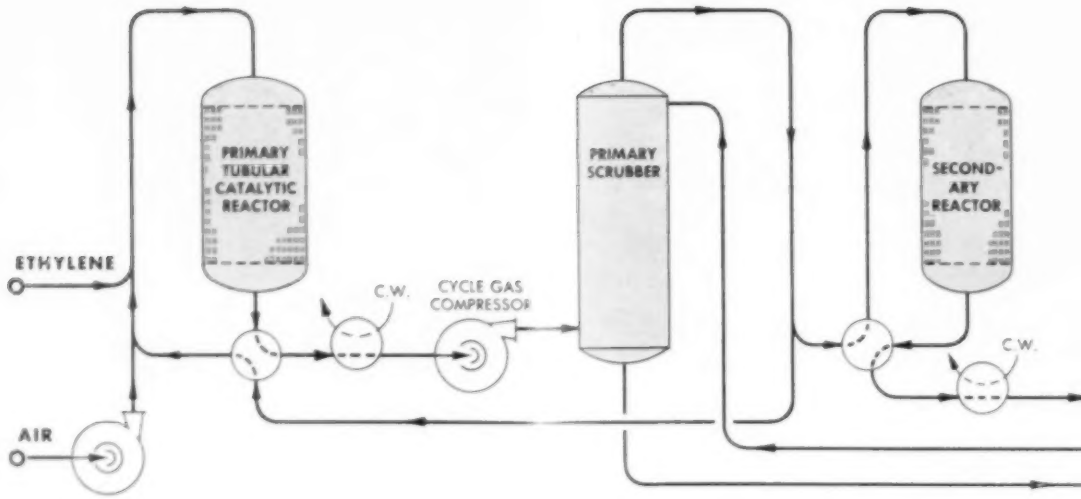

Process—Direct production of ethylene oxide by oxidation of ethylene over a fixed-bed, silver-containing catalyst.

Process Flow—Ethylene is catalytically oxidized to ethylene oxide in an exothermic reaction using air or oxygen, after which the oxide is absorbed in a simple scrubbing system followed by distillation and purification.

Referring to the flow diagram, ethylene, air and recycle gas are mixed and fed to a multitubular, catalytic reactor. Reactor temperature is closely controlled by an organic cooling medium. Reactor effluent gases—containing ethylene oxide—are cooled and scrubbed with water. Scrubber overhead gases are mostly recycled to the reactor, with the remainder of the gases being diverted to a secondary reaction system where operating conditions are adjusted to convert the remaining ethylene. Gas from the secondary reactor is cooled and scrubbed, then purged to the atmosphere.

The dilute ethylene oxide solution from the two scrubbers is stripped of its oxide content by heating. Stripper overhead gases are partially condensed to enrich the gas mixture in ethylene oxide and deplete it of water vapor. The resulting crude oxide vapor is compressed and refined in a conventional distillation train.

Auxiliary equipment—such as a purge gas scrubber or a product cooler—may be of economic benefit. Carbon dioxide and other light ends may be first stripped out of the oxide, and then pure ethylene oxide may be distilled away from water and other heavier liquids in a refining column.

Pure ethylene oxide product is pumped as a liquid to storage tanks which are blanketed with inert gas.

Raw Materials—Ethylene and air are the only important raw materials. The ethylene must be of fairly high purity, though less pure than is required for the manufacture of polyethylene.

While theoretically the process may be designed to use either air or oxygen, Scientific Design Co. studies show that unless the oxygen is free, the use of air is cheaper in operating cost and capital investment. The potential advantages of oxygen cannot be realized in practice because of the need for low oxygen concentrations in the recycle gases to avoid explosion hazards.

Catalyst—A fixed-bed catalyst which contains silver as its principal active ingredient is used. The fact that silver could be used as a catalyst was originally discovered in 1930 and patented by Lefort in France. Catalyst durability and long life eliminate the need for regeneration during normal operation. Therefore, there is little advantage to the use of fluidized catalyst beds or spare "swing" reactors.

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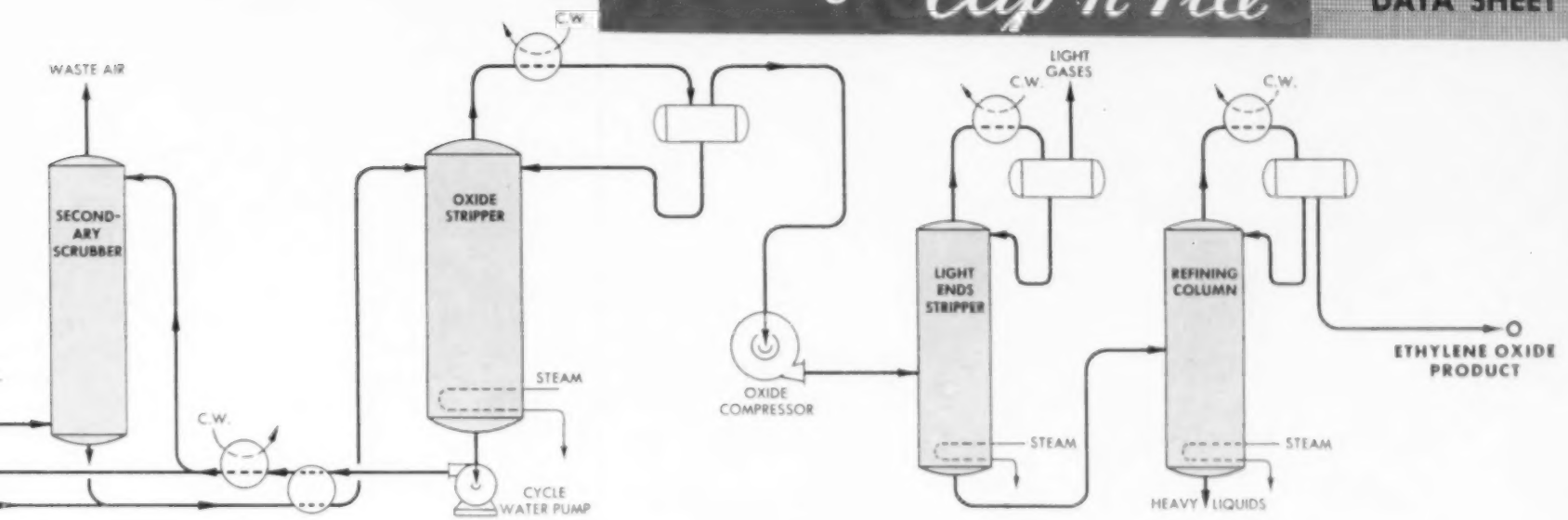
PETROLEUM PROCESSING, November, 1955



Ethylene Oxide

By Direct Oxidation of Ethylene

UNFOLD ← **FOR START OF PROCESS DESCRIPTION**

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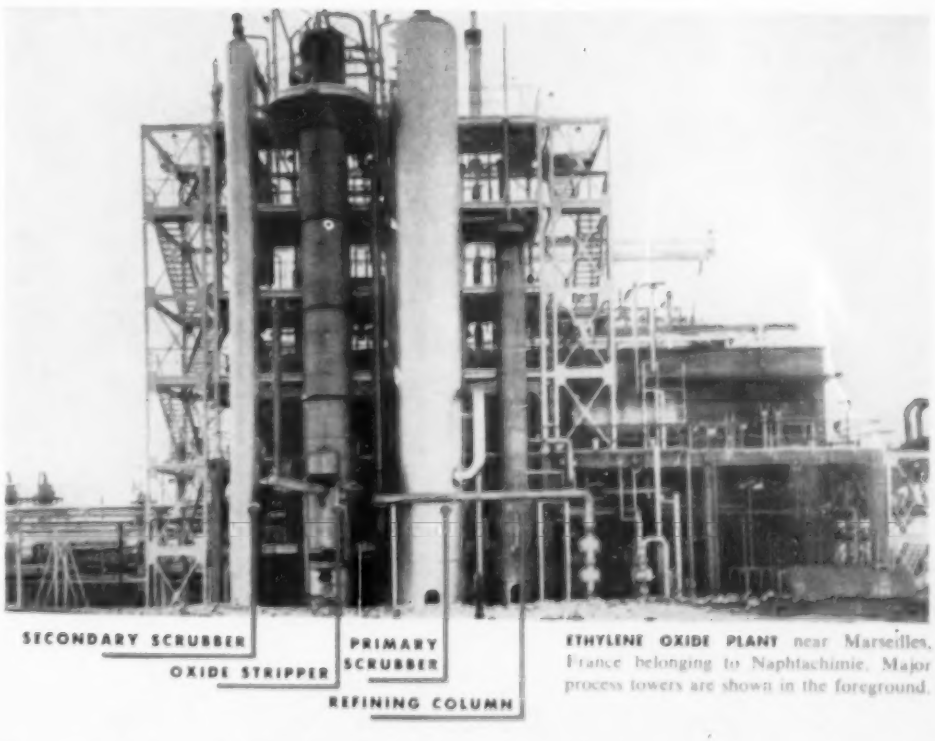
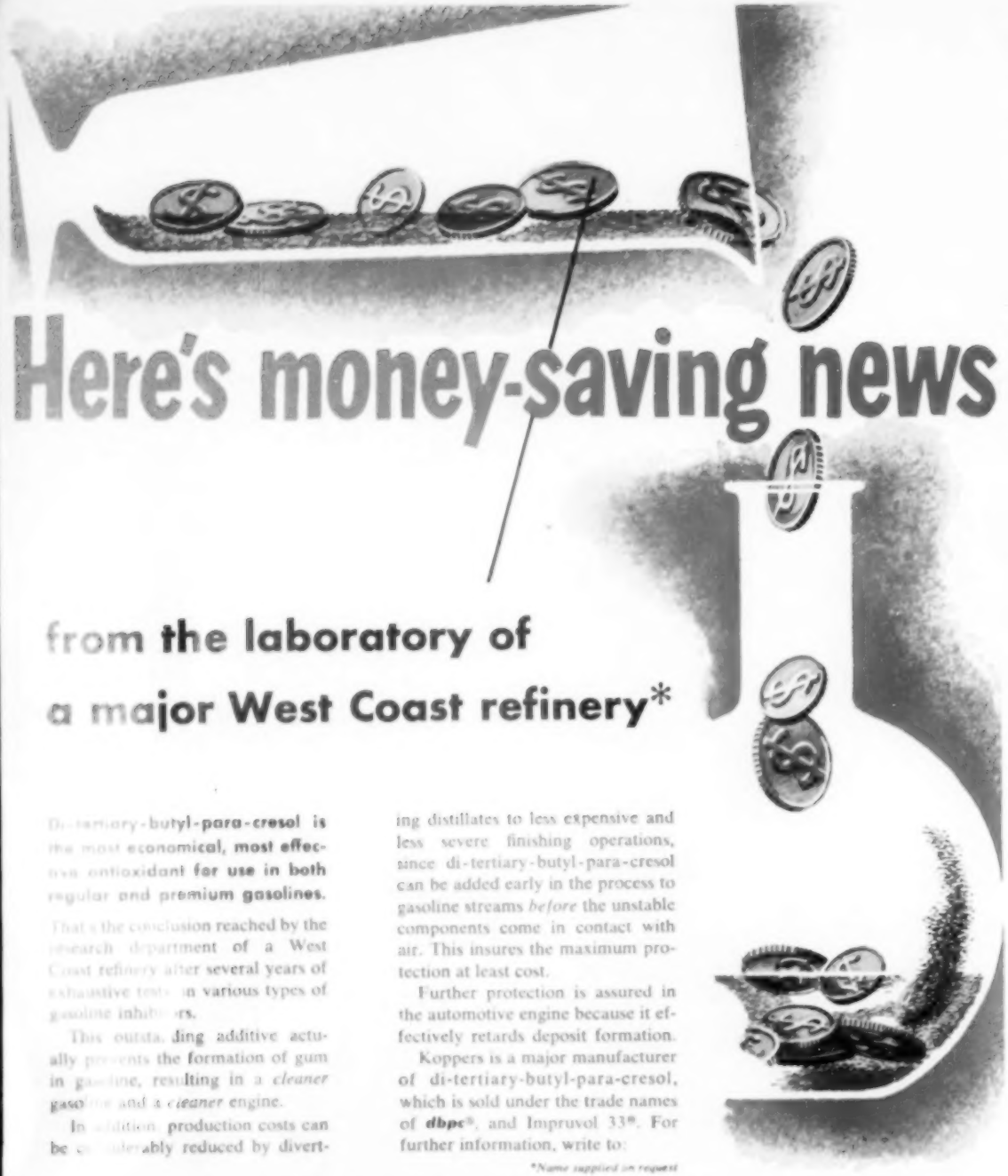


ETHYLENE OXIDE PLANT near Marseilles, France belonging to Naphtachimie. Major process towers are shown in the foreground.



Here's money-saving news

from the laboratory of a major West Coast refinery*

Di-tertiary-butyl-para-cresol is the most economical, most effective antioxidant for use in both regular and premium gasolines.

That's the conclusion reached by the research department of a West Coast refinery after several years of exhaustive tests in various types of gasoline inhibitors.

This outstanding additive actually prevents the formation of gum in gasoline, resulting in a *cleaner* gasoline and a *cleaner* engine.

In addition, production costs can be considerably reduced by diverting distillates to less expensive and less severe finishing operations, since di-tertiary-butyl-para-cresol can be added early in the process to gasoline streams *before* the unstable components come in contact with air. This insures the maximum protection at least cost.

Further protection is assured in the automotive engine because it effectively retards deposit formation.

Koppers is a major manufacturer of di-tertiary-butyl-para-cresol, which is sold under the trade names of **dbpc**®, and Impruvol 33®. For further information, write to:

*Name supplied on request

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etion or the efficient
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ion to every detail of construction
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efficiency is most adequately
have selected Procon to
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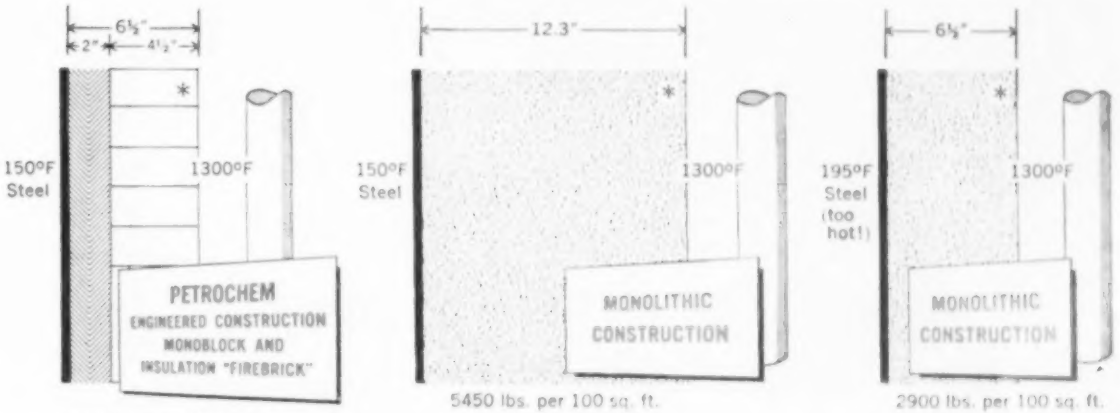
LD-WIDE CONSTRUCTION FOR THE PETROLEUM
OCHEMICAL, AND CHEMICAL INDUSTRIES

re data on advertised products see page 1800)

In furnaces as in processes compare the design to judge the advantages

As an example:

The wall construction of all Petrochem-Isoflow Furnaces is designed for 150°F maximum outside shell temperature.



1250 lbs. per 100 sq. ft. | 5450 lbs. per 100 sq. ft. | 2900 lbs. per 100 sq. ft.

*Based on B & W values.

The Petro-Chem design provides a thoroughly engineered wall construction. It is built with two tiers of monoblock supported on 18 inch centers and a circular arched wall of insulating firebrick. The inside of the steel shell is protected from the possibility of corrosion by a one-eighth inch thickness of Staylastic cement. This type of construction, independently supported monoblock and the circular arch of firebrick, bonded with Smoothset mortar, assures optimum efficiency and minimum maintenance.

The use of monoblock and insulating firebrick laid as a circular arch provides many advantages over a one-piece monolithic lining, including:

1—Low weight, 2—Low heat conductivity, 3—High hot crushing strength, 4—Low expansion coefficient, 5—Resilient compressible backing, 6—Long life, 7—Nil maintenance.

Also, this construction has low heat storage capacity, speeds both heating and cooling. Its light weight requires less concrete foundations and steel supports.

Compare and your judgment will affirm
Petrochem-Isoflow Furnaces are Most Efficient by any Comparison

PETROCHEM-ISOFLOW FURNACES

UNLIMITED IN SIZE . . . CAPACITY . . . DUTY

PETRO-CHEM DEVELOPMENT CO., INC. • 122 EAST 42nd St., New York 17, N. Y.

REPRESENTATIVES: Rawson & Co., *Houston* • Wm. H. Mason Co., *Tulsa* • Lester Oberholtz, *Los Angeles* • Faville-Levally, *Chicago* • D. D. Foster, *Pittsburgh* • Turbox, *Philadelphia* • Flagg, Brackett & Durgin, *Boston*

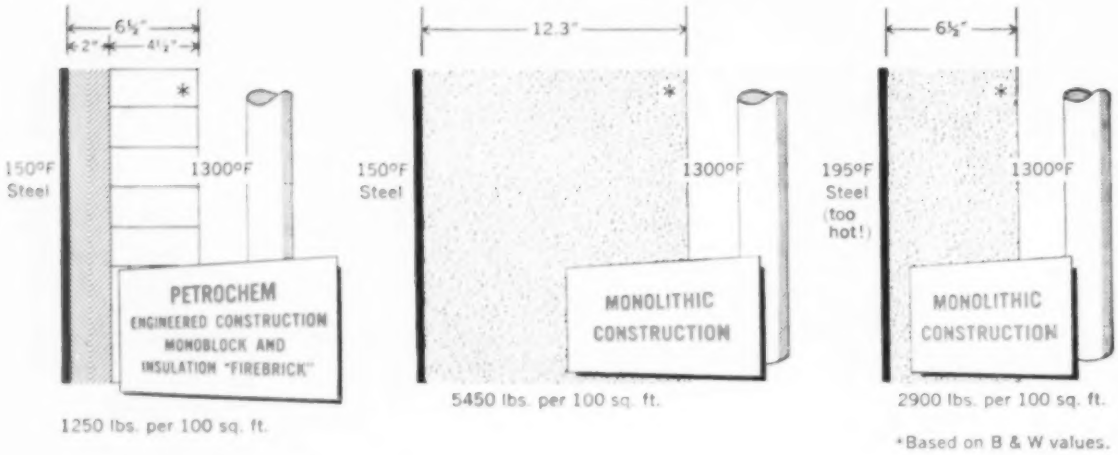
International Licensees and Representatives: SETEA—S.A. Commercial, Industrial, y de Estudios Tecnicos, Buenos Aires, Argentina • Industrial Proveedora, Caracas, Venezuela • Firma Dr. C. Otto & Comp. G.M.B.H., Germany • Birwelco Ltd., Birmingham, England • Societe Anonyme Heurtey, Paris, France • Societe Anonyme Belge, Liege, Belgium • Huertey Italiana S.P.A., Milan, Italy

(To obtain more data on advertised products see page 1800)

In furnaces as in processes compare the design to judge the advantages

As an example:

The wall construction of all Petrochem-Isoflow Furnaces is designed for 150°F maximum outside shell temperature.



1250 lbs. per 100 sq. ft.

5450 lbs. per 100 sq. ft.

2900 lbs. per 100 sq. ft.

*Based on B & W values.

The Petro-Chem design provides a thoroughly engineered wall construction. It is built with two tiers of monoblock supported on 18 inch centers and a circular arched wall of insulating firebrick. The inside of the steel shell is protected from the possibility of corrosion by a one-eighth inch thickness of Staylastic cement. This type of construction, independently supported monoblock and the circular arch of firebrick, bonded with Smoothset mortar, assures optimum efficiency and minimum maintenance.

The use of monoblock and insulating firebrick laid as a circular arch provides many advantages over a one-piece monolithic lining, including:

1—Low weight, 2—Low heat conductivity, 3—High hot crushing strength, 4—Low expansion coefficient, 5—Resilient compressible backing, 6—Long life, 7—Nil maintenance.

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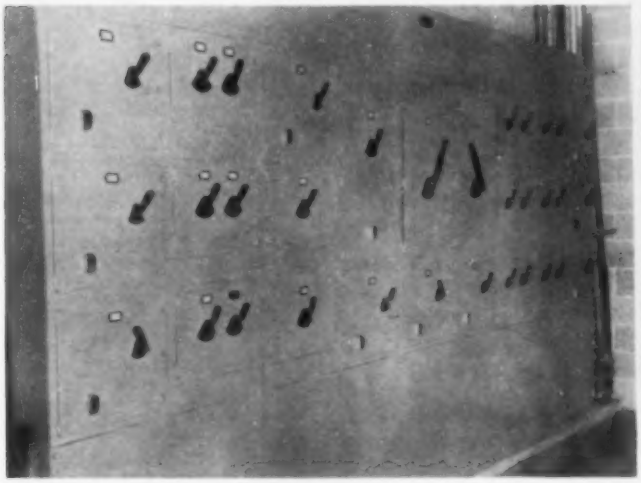
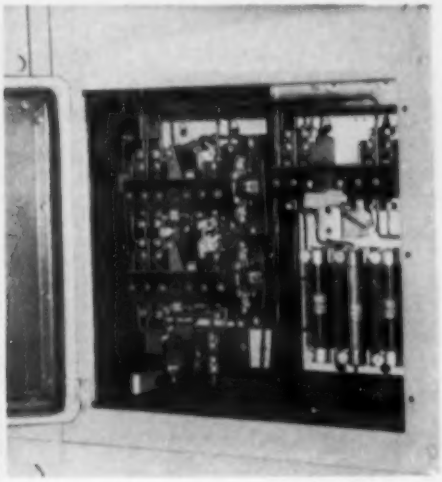




CONVERTED UNITROL PANEL BOARD serves as a centralized power distribution panel; photo at right shows detail of typical section

Unitrol Panel Makes Central Power Panel

IDEALLY, a centralized shop consuming large amounts of electric power should have a centralized power distribution panel.

Socony Mobil Oil Co.'s refinery at East Chicago, Ind., now has a central maintenance shop for pipefitting, welding, machine shop, electric shop, instrument shop, pump repair, tool room, labor assembly, etc.

Commercial estimates for a centralized power distribution panel to fit Socony's needs were as high as $25,000. Unwilling to pay this amount, Socony found that they had an old Cutler-Hammer "Unitrol" panel board languishing in storage. This panel had been used on the motor operated valve sequence set-up for an old Houdry unit no longer in operation.

Using the Unitrol panel, and doing its own work, the Socony maintenance section was able to modify this panel and fully equip it for use as a power distribution panel for slightly over $2000—including labor and materials.

Located in the corridor between the main shop area and the electric shop, this panel is conveniently placed for use by both the main shop area and the electricians in their shop.

How to Straighten Bent Shafts with Heat

(answer to question on p. 1729)

A mechanic wishing to straighten a bent shaft with heat could do so by applying the heat to the outside of the bend in the shaft.

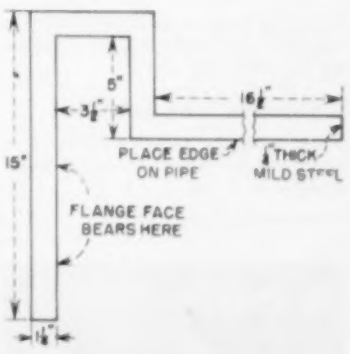
Localized heating causes this side to expand against the resistance of the cold side, giving stresses above the elastic limit and a permanent shortening of the longest fiber. If proper heat is applied, the length of the two sides is the same when the shaft is cooled. If the inside of the bow in the bent shaft is heated, the metal will be upset also; only when the shaft cools, there will be more bow.

Another way of straightening the shaft with heat is to heat both sides of the bow, and quench at the inside of the bow, permanently stretching the fibers so that the cooled shaft is straight.

Jig Speeds Flange Lineup

Squaring-up a slip-on or welding neck flange on a section of pipe is a time-consuming job which must be done accurately or more time will be spent later during the actual pipe installation. A jig developed by pipe-shop personnel at Cosden Petroleum Corp.'s Big Spring, Texas, refinery makes the task simple, just like the jig.

The jig shown in the drawing will accept up to an 8-in. flange. Critical items are that the 15-in. edge of the jig which aligns the flange must be exactly perpendicular (square) to the 16½ in. reference bar. The actual dimensions given are not extremely precise. It is sufficient that enough length be alloted to the reference edge



FLANGE LINEUP JIG in position to speed pipe assembly

No Galling of Threaded Parts When You Use

Swagelok®

GOOP*

New Swagelok Goop thread lubricants are used to eliminate the "welding action" or galling in pulling up threaded parts of stainless steel, nickel, Monel, titanium and aluminum. A light application of Goop to threads so protects them that the threaded parts can be used over and over again.

Swagelok Goop lubricants available in two types:

- **Blue Goop for use on titanium, stainless steel and aluminum for temperature ranges up to 400° Fahrenheit.**
- **Silver Goop for use as an effective antiseize compound for use on stainless steel and high temperature alloys for temperature ranges up to 2,000° Fahrenheit.**

Swagelok Goop is made by the Crawford Fitting Company, makers of Swagelok Tube Fittings.

Generous Free Sample

Write today for complete information and a sample tube of Swagelok Goop. Address Dept. DS.

*T. M. Patent Applied For

CRAWFORD FITTING CO.
884 E. 140th Street
Cleveland 10, Ohio

to give good, average bearing, and adequate clearance to accept the maximum-sized flange be allowed in the throat of the jig.

The jig is placed with the reference bar on the pipe and over the flange which has been roughly aligned by eye and tacked lightly to provide welding clearance. The face bar is pulled up tight against the flange and the latter is moved until the flange face is in full contact with the jig. When in this position, flange is tacked top and bottom. (Tacked only once if a clearance-tack was made before squaring-up.)

The jig then is moved about 90° from its former position and the flange realigned for contact as previously described. Light hammering is permissible in this operation, but only on the bolt circle; *never* hammer the face of a flange if a leak-free joint is desired. The flange is tacked again, preferably at just one point in case the flange proves not to be square when rechecked.

Recheck for squareness by moving the jig either back to its original position or some other, new position just to be sure something did not slip. That done, the flange is welded in the usual manner.

Sewer Repaired Without Removal

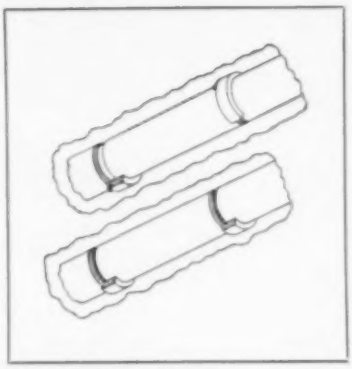
By W. L. MacDONALD

Repairs to refinery sewer systems have often involved expensive excavation and labor in order to replace a single broken section. Oftentimes the sewer stream has to be shut off or diverted when making repairs.

Engineers at Sinclair Refining Co.'s Marcus Hook, Pa., refinery decided to take steps to curtail or eliminate the extensive use of men and equipment each time a sewer began to leak. A plan evolved whereby the damaged section could be replaced without tearing up the line. In fact, if the break is located in the upper half of the sewer pipe, the flow of sewage need not be altered.

On serious breaks, the top half of the bell on the new pipe section is removed. With these sectors removed, the replacement may be lowered horizontally into place without disturbing the adjacent pipe.

The new pipe is then merely rotated through 180°. To insure a tight fit, the two missing bell sections are then reformed with concrete and service is restored with a minimum of down time.



IN-PLACE SEWER REPAIR: new section is dropped in place (upper drawing), then rotated 180° (lower drawing)

If the section is damaged only on the top, the old piece is cut in half lengthwise and replaced with a new half sleeve. Since a cemented joint may not form a good seal, a concrete envelope is poured around the entire section.

Mr. MacDonald is a Civil Engineer at Sinclair Refining Co.'s Marcus Hook, Pa., refinery.

Baffle Holes Reduce Tube Failures

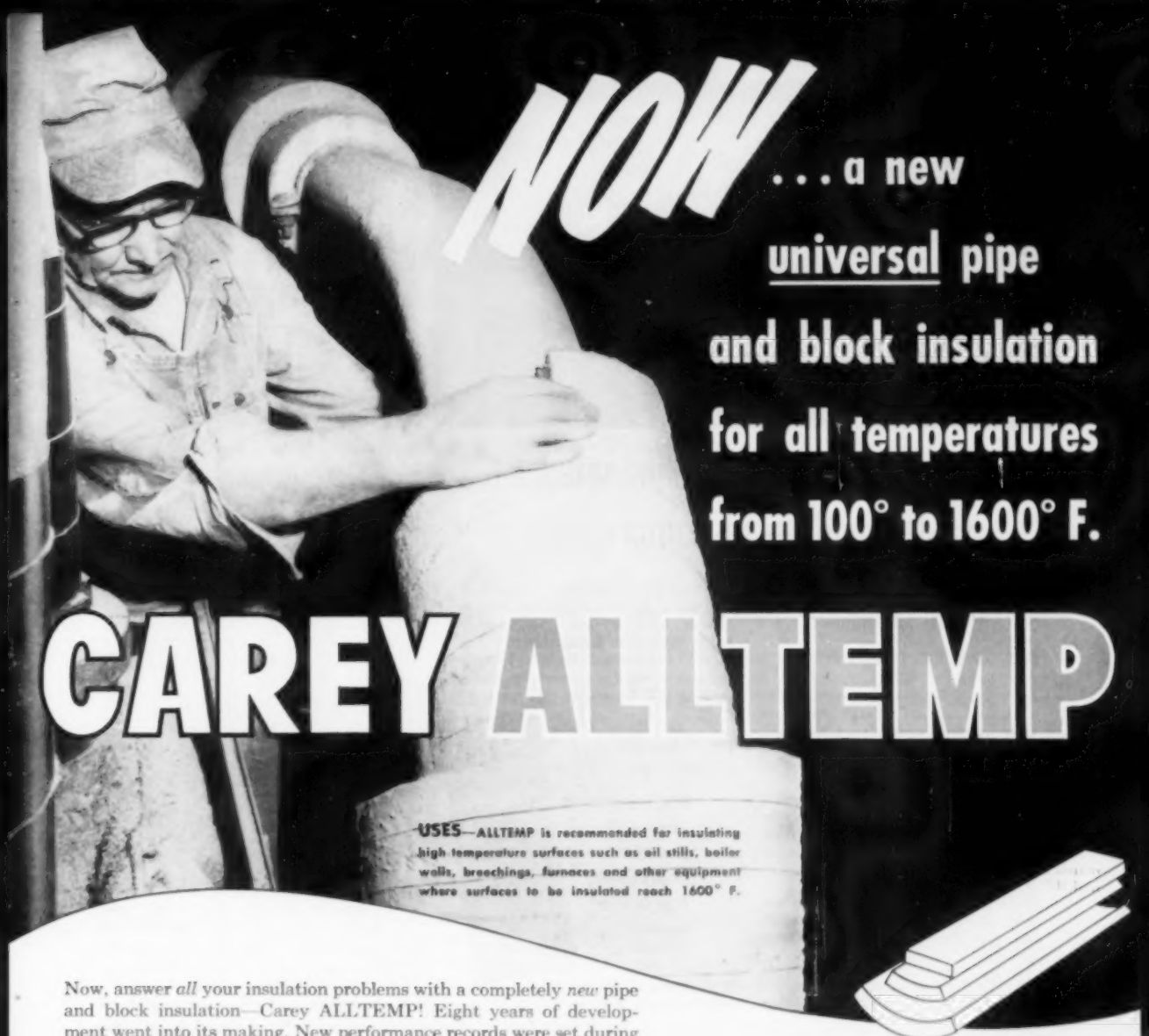
Have you tried "perforated" horizontal baffle plates to reduce tube failures in overhead condensers?

The East Chicago, Ind., refinery of Socony Mobil Oil Co. noticed that a preponderance of condenser tube failures were concentrated immediately above the center of the horizontal baffle plates.

Inspection showed that sediment from the shell-side overhead oil stream collected in this "dead" nonturbulent area. The sediment would build up until a number of the closest tubes were covered, resulting in excessive corrosion and tube failures.

The solution to the problem was found to be drilling ½-in. holes on 6-in. square centers over the entire area of the horizontal baffle plate, as shown above.

These holes encouraged extra turbulence above the baffle plate, allowing the sediment in the shell-side oil



NOW . . . a new universal pipe and block insulation for all temperatures from 100° to 1600° F.

CAREY ALLTEMP

USES—ALLTEMP is recommended for insulating high temperature surfaces such as oil stills, boiler walls, breechings, furnaces and other equipment where surfaces to be insulated reach 1600° F.

Now, answer *all* your insulation problems with a completely *new* pipe and block insulation—Carey ALLTEMP! Eight years of development went into its making. New performance records were set during exhaustive field and laboratory tests. Here it is—*a brand-new industrial insulation* for all temperatures up to 1600° F.

ALLTEMP keeps every last BTU on the job producing power. Its extremely low percentage of shrinkage—approximately ⅔ *less* than other 1200° F. insulation materials—means joints won't open, cracks won't appear in covering. BTU's are *locked in!* ALLTEMP retains its high thermal efficiency and structural strength even after long, continuous exposure to excessive heat and moisture. Non-brittle, it resists blows, abrasions; won't crack or crumble under severe service conditions. And it's easy on the hands—easy to cut, fit, install!

Get all the cost-saving facts on new ALLTEMP today and your copy of the Carey ALLTEMP specification folder.
Just address coupon below.

ALLTEMP RECOMMENDED THICKNESS

Nominal Pipe Size Inches	Temperature Difference °F 80° Air					
	200	400	600	800	1000	1200
	Nominal Thickness, Inches					
1½ & Under	1	1	1½	2	2½	3
2	1	1½	2	2½	2½	3
2½	1	1½	2	2½	3	3½
3	1	1½	2	3	3	3½
3½	1	1½	2	3	3½	3½
4	1	1½	2½	3	3½	4
4½	1½	2	2½	3	3½	4
5	1½	2	2½	3	3½	4
6	1½	2	2½	3½	4	4½
7	1½	2	2½	3½	4	4½
8	1½	2	3	3½	4	4½
9	1½	2	3	3½	4½	5
10	1½	2½	3	4	4½	5
11	1½	2½	3	4	4½	5
12	1½	2½	3	4	4½	5
14 & Over	1½	2½	3½	4	4½	5½

ALLTEMP is available in clean, easy-to-handle flat and preformed blocks. "Nesting" O.D. pipe covering sizes provide accurate, tight fits for multiple layer construction. Only a limited number of "prime" units are necessary for unusual assemblies.

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Carey

THE PHILIP CAREY MFG. COMPANY
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In Canada: The Philip Carey Co., Ltd., Montreal 3, P.Q.

Carey-approved contract units in major trading areas. Consult your nearest Carey District Office or your Telephone directory.

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Lockland, Cincinnati 15, Ohio • Dept. PP-11

Please send free illustrated folder showing specifications, installation details and complete facts on new ALLTEMP insulation.

☐ Have your Industrial Sales Engineer call without obligation.

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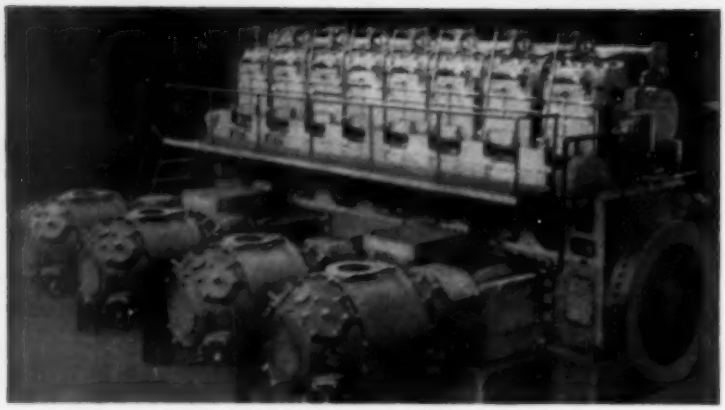

How one refinery eliminated scale build-up in compressors

Oakite Airefiner No. 52 prevents scale formation— cuts downtime, maintenance

Every 6 to 8 weeks a Southwestern refinery had to run acid through compressor water jackets to remove thick lime scale deposits. That meant compressors down for half a day. What could Oakite do?

The Oakite Man first descaled the jackets with Oakite Compound No. 32. Then he charged the spray pond with Oakite Airefiner No. 52, and set up a schedule for maintaining proper pH in the solution.

Results: Manifold temperatures reduced — no more descaling, no more cracked blocks or heads, no more compressor downtime.

Proving that — in industrial cleaning it always pays to consult Oakite.

Call your Oakite Technical Service Representative. His experience is yours to draw on. He'll study your cleaning problem, suggest and demonstrate the best material and method. He'll keep checking back to see that you get top quality cleaning at low cost. Call him today!

FREE HANDBOOK— full of facts on

- Drum reconditioning
- Descaling
- Cleaning tanks
- Salvage cleaning
- Paint stripping
- Cleaning tank car interiors

Write Oakite Products, Inc., 50D Rector St., New York 6, N. Y.

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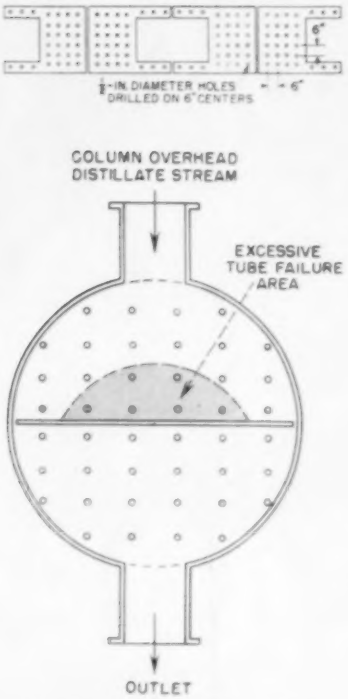


PERFORATED BAFFLE PLATES greatly reduce tube bundle failures

stream to pass over, or through the baffle.

Some commercial baffles purchased by Socony already had ¼-in. holes drilled, but Socony has found it advisable to increase these holes to the ½-in. size.

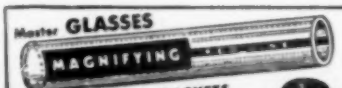
Since Socony has made it a policy to perforate all overhead condenser horizontal baffle plates, the tube failure pattern shown in the drawing has been eliminated—more than adequate compensation for any small theoretical loss in exchanger cooling efficiencies resulting from the baffle perforations.

•

"Soyez les Bienvenus à Montréal au Mois de Mai!"

•

Master **GLASSES**



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All sizes to fit your gages

ERNST WATER COLUMN & GAGE CO.

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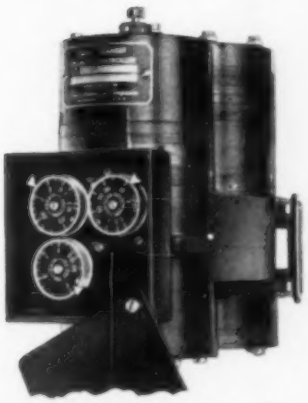
TRANSET* System sets low maintenance records!

BELIEVE IT OR NOT, we've actually heard maintenance men complain because their Transet Instruments never give them a chance to use the maintenance "know how" they had so studiously acquired. For months and, is some cases, even years at a time the instruments require no attention. Here are some reasons for this outstanding dependability:

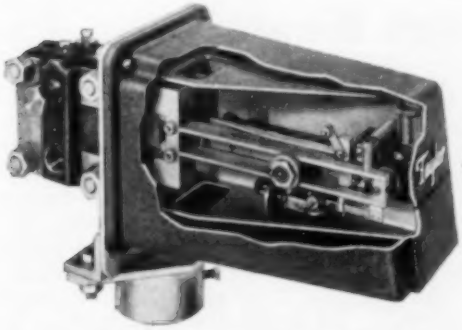


CONTROLLERS

Design and flexibility of neoprene-impregnated diaphragms makes for strength and long life. Can be used on pulsating flows without deteriorating, and are impervious to oil vapors often present in air systems. Simple circuit reduces number of possible trouble points, and force-balance action means minimum of moving parts. Large volume relay valve reduces chances of plugging. Unique nozzle-baffle arrangement is not as susceptible to damage as in other controllers. Built in cut-off relay permits locating instruments behind board or in the field with no change in interchangeability of recorders. Only two adjustments are ever needed for maintenance—and plug-in feature means minimum time off automatic control.

RECEIVERS

Ruggedly housed bellows in receiver units protects it from external damage. Continuous bleed from the reducing valve keeps it purged—free from dust and dirt. Many have been in service over four years without requiring calibration to zero. Units are easy to get at for service, no matter how close on the board, because they can be unplugged. Plug-in feature also means that indicators can be replaced by recorders for analyzing trouble. Removable chart drive is another aid to establishing process problems.



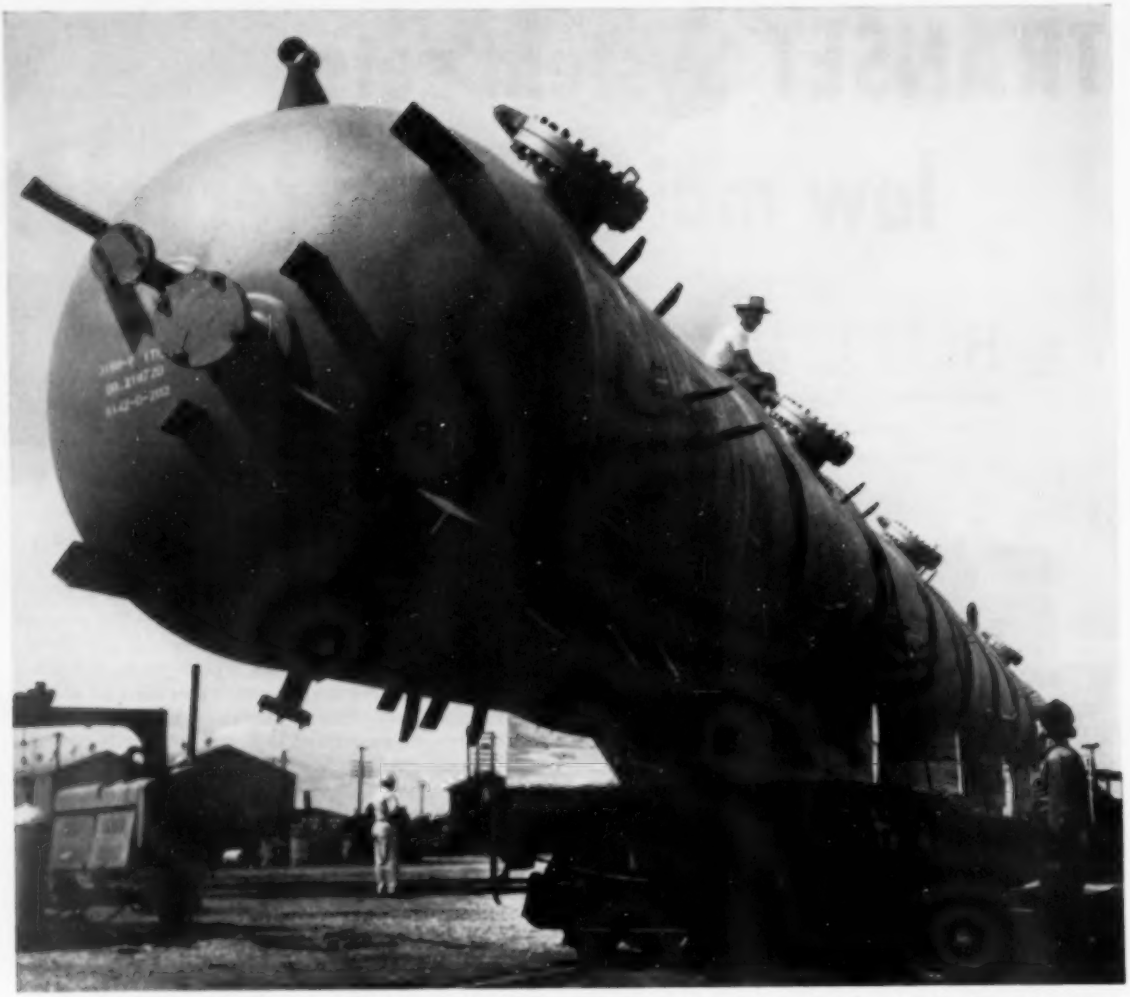
TRANSMITTERS

Both temperature and flow transmitters are ruggedly housed. Located at the point of measurement, they are out of the way of possible damage. Quick, simple range-change features mean minimum maintenance time for changes in product or seasonal demand. Force-balance construction—no seal pots. Follows flows quickly because of low volumetric displacement. Self draining and venting.

For full details about the TRANSET system call your Taylor Field Engineer, or write for **Bulletin 98097**, Taylor Instrument Companies, Rochester, N. Y., or Toronto, Canada.

*Reg. U.S. Pat. Off.

Taylor Instruments MEAN ACCURACY FIRST



THIS ENTIRE VESSEL was radiographed. Built for use by Socony Mobil Oil Company, Incorporated, it was stress relieved in thirds, and the two joints were stress relieved locally. The unit contains 30 uniflex trays of 96" diameter. Overall weight: 152,000 lbs.

Among the largest in use

...built by Newport News

This Debutanizer with a 110 feet 6 inches over-all length is typical of units that are readily built by Newport News . . .

In fact, Newport News can fabricate almost any type of pressure vessel or other heavy equipment used in the petroleum, chemical or other processing industries.

But at Newport News you'll find more than large productive capacity.

In vast fabricating shops, in huge machine shops, foundries and forging plants, Newport News craftsmen complete your order with specialized techniques. Plant methods . . . developed as a result of specializing for more than half a century . . . enable Newport News to provide money-saving answers to all sorts of heavy equipment problems.

Newport News craftsmen handle the job exactly as you want it done . . . for maximum results per dollar invested. So let us bid on your present or future projects. Learn how Newport News can help you. Send for our illustrated booklet entitled, "Facilities and Products"...it's yours for the asking.

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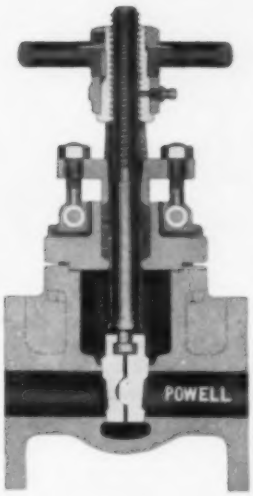


Powell Valves are the choice of engineers because they know every valve is precision made, meeting every specification—every time.

And there are other good reasons why engineers prefer Powell Valves—because Powell Valves are dependable . . . economical . . . and Powell has the COMPLETE quality line of valves.

Consult your Powell Valve distributor. If none is near you, we'll be pleased to tell you about our complete line, and help solve any flow control problem you may have.

The Wm. Powell Company
Cincinnati 22, Ohio...109th year

FIG. 2495 (Sectional)—Stainless Steel O. S. & Y. Gate Valve for 150 Pounds W. P. Double Wedge Disc is accurately guided to seat.

FIG. 375—Bronze Gate Valve for 200 Pounds W. S. P.

FIG. 2309—(Sectional)—Flush Bottom Tank Outlet Valve for 150 Pounds W. P. Disc Opens Into Tank.

FIG. 2193—Large Ni-Resist* Gate Valve for 200 Pounds W. O. G.

*Trade-mark of The International Nickel Co.

POWELL VALVES

SHELL REPORTS

A PICTURE ROUNDUP OF SOME ACTIVITIES THAT MADE NEWS OUTSIDE THE PETROLEUM WORLD

LIGHTWEIGHT HEAVYWEIGHT. The problem was to build a truck that would weigh less and carry more. That's why Shell's Midland, Texas Area engineers designed this all-aluminum truck. The net weight saving is almost 2½ tons. Power steering, unique torsion bar suspension, and the new, larger pay loads can mean the start of a new era in oil industry trucking—Shell's contribution to lower cost handling of oil field equipment.

Sherm, Les, Gus and Warren Schuermann

FOUR FOR SHELL. Even as kids selling hot dogs in a St. Louis ball park, the four Schuermann brothers were well on their way to becoming successful businessmen. Today, Les, Gus and Warren run three profitable Shell service stations in St. Louis. Sherm is Shell's retail manager in the same area. Their meetings usually mean trips to the kitchen table where they swap information, ideas and criticism. Each brother is proud of the success of the others. And Shell is proud of the fine reputation the Schuermanns have built with their name alongside the sign of the Shell.

PLAYING IT SAFE. Two years ago, Shell salesman E. G. "Pete" Newbill was stranded overnight beside a lonely mountain road. Since that bitter-cold experience, Pete's been ready with bedroll, fuel, food, stove, tools, water—a complete survival kit to handle any emergency in northwest desert or mountain country. Selling in 75,000 miles of rural area isn't easy—but Pete's been doing it for 25 years. He knows Shell products and he knows how to get them to Shell's rural area customers.

Do You Know These Words?

By B. H. WEIL
Manager, Information Services
Ethyl Corp. Res. & Engrg. Dept.
Detroit, Mich.

A regular department intended to help administrators and operating men alike keep abreast of technical names and processes in the petrochemical field.

Thiophene

Thiophene, pronounced "**thigh**-oh-feen," is another "coal-tar chemical" which now has been added to the growing list of petrochemicals. A colorless liquid of pleasant, aromatic odor, thiophene is slightly heavier (per unit volume) than water, and it freezes and boils at temperatures somewhat lower than the corresponding values for the latter. Chemically it has the formula $(CH)_4S$, in which the four =CH- groups form a five-membered ring with the -S- (sulfur) radical.

Thiophene has not been available in large quantities until recently, its high cost serving to discourage wide use as a chemical intermediate. It was chiefly known as an expensive-to-remove contaminant of coal-tar benzene. Various methods of synthesis have been reported, including several using petroleum raw materials, but it was not until this year that fully-commercial production was initiated. Chief current uses are said to be the manufacture of pharmaceuticals and dyes, with potential uses including plastics, resins, agricultural chemicals, and photographic chemicals.

At present, thiophene is being synthesized from butane and sulfur. Butane, of course, is obtained from natural or refinery gases, and large quantities of sulfur are being obtained from the purification of similar gases.

Thiophene has long been an interesting chemical, one with intriguing chemical and physical properties. Now, perhaps, some predictions as to utility will at last be realized.

Cyanuric Chloride

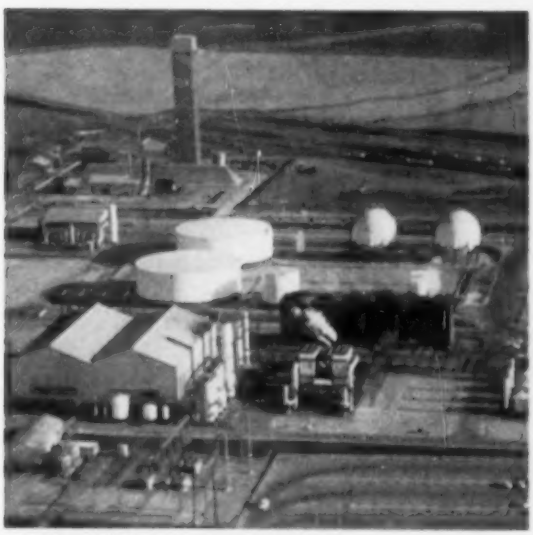
Cyanuric chloride, pronounced "**sigh**-ah-**nuhr**-ick **klo**-ride," is a unique cyclic chemical which is now being produced commercially from hydrogen cyanide, itself a petrochemical. Known chemically as 2,4,6-trichloro-1,3,5 triazine, the cyanuric chloride molecule contains a ("triazine") six-atom ring composed of three carbon atoms and three nitrogen atoms in alternating positions; to each carbon atom, also, a chlorine atom (chloride radical) is attached. It is a crystalline material of pungent, irritating odor, and requires special handling to prevent reaction with air-borne moisture.

Cyanuric chloride is produced by the reaction of hydrogen cyanide (HCN) with chlorine (Cl_2), yielding cyanogen chloride (CNCl) and hydrochloric acid (HCl). Following removal of the latter, the cyanogen chloride is then catalytically reacted with itself to yield cyanuric chloride, which is really $(CNCl)_3$.

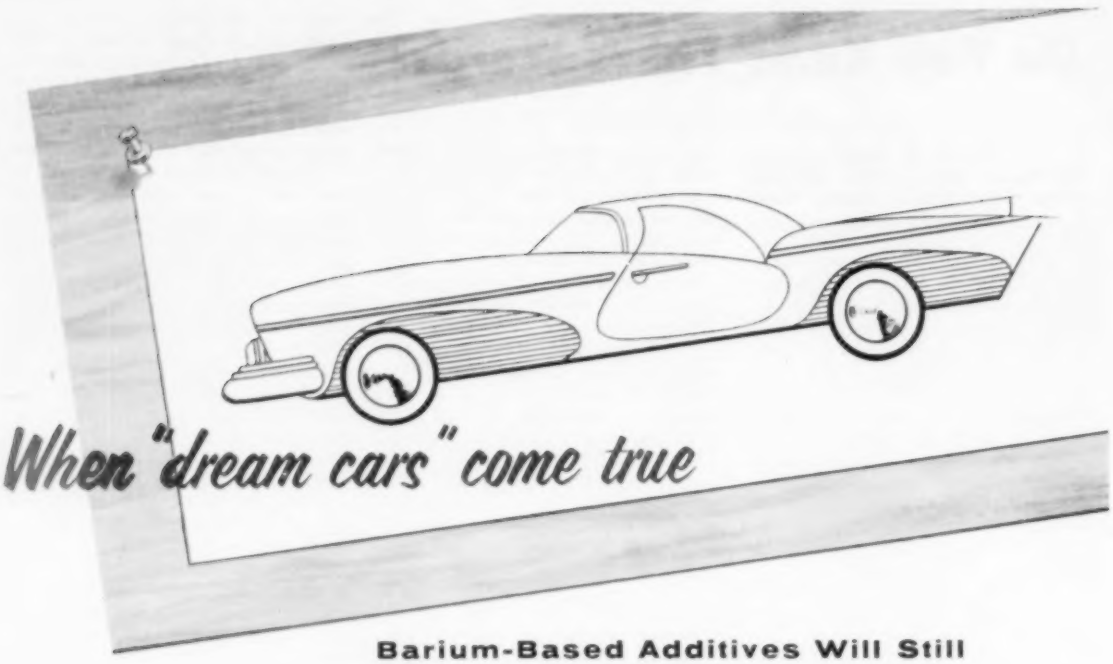
Only recently produced on a commercial basis, cyanuric chloride comes under the heading of fringe petrochemicals; i.e., its basic raw material —hydrogen cyanide—can be obtained from petroleum but can also be prepared in other ways. As a petrochemical, hydrogen cyanide is produced from methane gas (natural gas) and ammonia; the latter, in turn, is also produced from natural gas.

Uses for cyanuric chloride cover a rather astounding range, and include the manufacture of dyes, optical bleaches, explosives, surface-active agents, insecticides, heat-resistant plastics, and pharmaceuticals. One derivative has cured 100% of a certain type of rat cancer. It seems likely that the unique triazine ring in cyanuric chloride will lead to its application in still other fields.

NEWS in VIEWS



FIRST PLANT IN THE WEST to produce aluminum nitrate fertilizer prills is now on stream near Brea, Calif. Dominating the plant's 50-acre horizon is the world's tallest aluminum process structure, the 200-foot prilling tower shown at the right. Brea Chemicals' new plant will produce 50,000 ton/year of ammonium nitrate, the West's second most used dry simple fertilizer. Brea is a Union Oil Co. of Calif. subsidiary.



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Mr. Jackson

Mr. Wright

Robert M. Jackson has been appointed coordinator in charge of chemical products in the Standard Oil Co. (N.J.) refinery coordination department. In this post Jackson will act as coordinator of the company's worldwide petrochemical operations, including research, manufacturing and distribution. He was formerly assistant manager of the chemical products division of Esso Standard Oil Co. **John F. Wright** has become assistant coordinator of chemical products.

Jackson holds an M.S. degree from Massachusetts Institute of Technology and began his work in the petroleum industry the same year, 1932, as a refinery foreman in Wichita, Kan. He joined Jersey Standard two years later and worked in several of the company's affiliate organizations, becoming in 1946 assistant manager of Esso's chemical products department.

Wright, who will assist Jackson in the coordination of Jersey Standard's petrochemical activities, began with the company in 1936, shortly after graduation from the University of Wisconsin with a degree in chemical engineering. He held various technical and supervisory positions at the Esso Baton Rouge refinery from 1937 until 1951, when he became head of the technical department at Esso's Bayway refinery. He was appointed supervisor of the chemical products department in 1953 and head of the process department a year later.

Charles Leet, general manager of East Coast Manufacturing for Esso Standard Oil Co., has been elected a director of Creole Petroleum Corp., a Jersey Standard subsidiary. He will assume his duties with Creole in Venezuela at the end of the year.

His post with Esso will be given to **Fred Holloway,** who was recently appointed assistant general manager of the division.

FISHING IN SOUTHERN WATERS is a specialty of Powell Smith, of Esso Standard Oil's Baton Rouge refinery. His 1951 "Fishing Guide for Louisiana" has now been followed by a similar volume which adds Mississippi, northern Florida, and surrounding areas to another careful survey of fish and fishing in Louisiana. When not out researching with rod and reel, Smith may be found with one of his other hobbies, hunting, photography, or flying with the Civil Air Patrol.

Mr. Beamer

Dr. Wood

Clayton M. Beamer has been appointed general manager of chemical products for Imperial Oil Ltd. He was assistant general manager of the chemical products department at Esso Standard Oil Co. He has been succeeded there by **Dr. John E. Wood III,** who formerly headed the chemical products division at the Baton Rouge refinery.

Dr. Fred D. Tuemmler, Shell Development Co., was elected secretary of the analytical section of the International Union of Pure and Applied Chemistry at the Section's recent conference in Zurich, Switzerland. His term of office is from 1955-59.

Dr. Tuemmler began with Shell Development in 1937, after receiving his Ph.D. in chemistry from Harvard University. He also holds an M.A. in chemistry from Harvard, an M.S. degree in chemistry from the University of Illinois and a B.S. in chemistry from Shurtleff College.

Horace G. Chandler has been appointed superintendent of the Eagle Point works of the Texas Co., where he has been assistant superintendent since the fall of 1954. He succeeds **R. G. Aitken,** who has taken the manager's post in the refining division of Texaco's foreign operations department.

Assistant superintendent at Eagle Point is now **W. R. Sorenson,** who was assistant supervisor of the process division in New York.

Dr. Herbert R. Jensen has joined the staff of the American Petroleum Institute as supervisor of educational activities. He was professor of education and director of the Instructional Materials Center at Colorado State College of Education.

Dr. Jensen will direct the Institute's school program, in which educational material on the oil industry is prepared and distributed to secondary schools to be used as supplements to classroom studies.

Jack F. McKenna has joined the

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API's department of technical services. He was formerly safety director of Aurora Gasoline Co. and previously held the same post at Lion Oil Co. He has joined the safety and fire protection branch of the department.

G. Davidson has been appointed vice-president, manufacturing, of Shell Oil Co. of Canada. He has been manager of the company's Montreal East refinery for the past five years, and he succeeds Dr. D. M. Morrison, who was recently elected president of Trans Mountain Oil Pipe Line Co.

Mr. Davidson

Davidson joined Shell in 1925 following his graduation from the University of Glasgow with a B. Sc. degree. His first assignment was at Tampico, Mexico, where he rose to the position of refinery superintendent in 1932. In 1934 he became manager of the Aruba refinery and three years later moved to the refinery at Wood River, Ill.

During World War II he was assistant manager of the Stanlow refinery in Europe, and in 1944 he took up a senior position in Shell's manufacturing department in the U.S. His appointment to Canadian Shell's Montreal East refinery came in 1951.

Dean A. McGee, president of Kerr-McGee Oil Industries, Inc., was honored recently as the "Outstanding Industrialist of the South" by the Southern Association of Science and Industry.

E. K. Lewis, superintendent of Imperial Oil's Ioca refinery, near Vancouver, has succeeded **H. H. Moor** as head of the company's Edmonton refinery.

Moor, who has been in charge of the Edmonton plant since its erection in 1947, has been appointed head of the company's Imperoyal refinery at Halifax, which is now undergoing a $30 million expansion program.

Neal B. Prichard has succeeded **George H. Burruss** as vice-president of manufacturing of the Anderson-Prichard Oil Corp. Burruss retired after directing the company's manufacturing and pipeline activities for 29 years.

Prichard, a nephew of the firm's co-founder, L. H. Prichard, is a petroleum engineering graduate of the University

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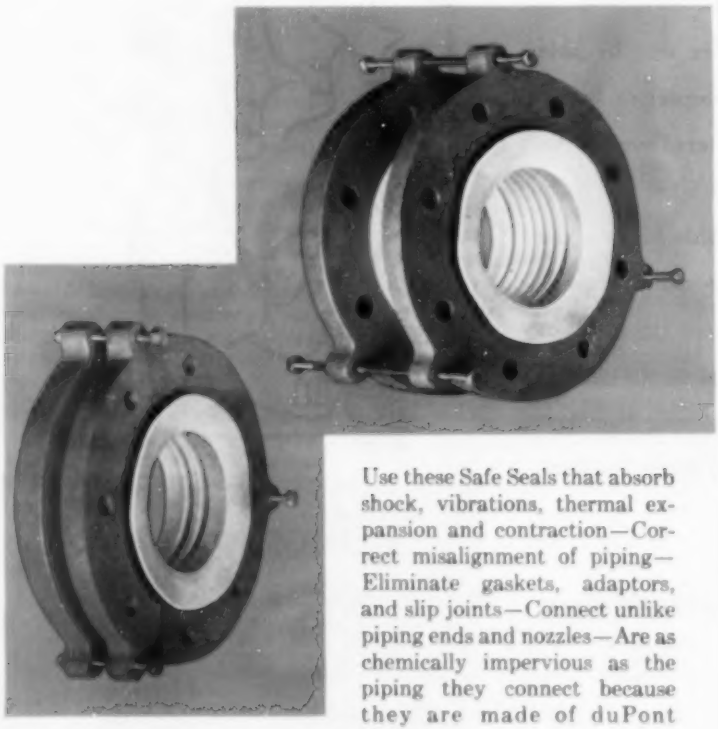

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of Oklahoma. He began with the firm in 1931 at the Col-Tex refinery in Colorado City, Tex. He became the refinery's superintendent in 1938 and was transferred to the general office to assist Burruss in 1946, eventually becoming general superintendent of refineries. Prichard became a board member in 1948.

J. C. Bradley has replaced Prichard as general superintendent of refineries. He has been with the company since 1939 and has served as superintendent of each of the firm's refineries.

G. B. Hunter, president of Quaker State Oil Refining Corp., is the 1955-56 president of the National Petroleum Association, succeeding A. W. Scott, president of Wolf's Head Oil Refining Co. He also was re-elected treasurer, giving him two offices in the group.

First vice-president is **Paul R. Beck,** Pennsylvania Refining Co., who was before second vice-president.

Rex S. Blazer, Ashland Oil & Refining Co., was elected second vice-president.

Carl W. Rehfuss has been appointed general manager of Standard Oil Co. of California's Richmond refinery. He succeeds R. K. Rowell, general manager since 1945, who has left after 38 years with the company.

Mr. Rehfuss

Previously assistant general manager of the refinery, Rehfuss has been with Standard since 1924 and on the management staff at Richmond since 1940. He is a graduate of Stanford University and a former teaching fellow at the University of California.

His former assignment has been taken by **M. F. Miller,** who was the refinery's manager of operations. Miller, a graduate of the University of California, has been with Standard of California since 1926. His post has been assumed by **T. M. Sheehy,** a graduate of the University of Washington and an employee of the company since 1937 He previously held the position of assistant manager of the operations planning division, in San Francisco.

Kenneth A. West has been appointed manager of manufacturing for Canadian Oil Companies, Ltd. West was formerly the assistant manager of manufacturing, and he has also be-

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come a member of the management committee.

He began with Canadian Oil in 1951 as chief process engineer. In 1952 he was made production superintendent at the Sarnia refinery, and in the following year took his most recent post.

Mr. Britton

Mr. Loving

J. Boyd Britton, former executive assistant to the operations vice president of Godfrey L. Cabot, Inc., has been elected operations vice president. A 1929 graduate of Washington University with an A.B. degree, Britton joined Cabot in 1937 as a salesman after several years with a petroleum company. In 1942 he became assistant sales manager, and in 1945 assistant to the vice president.

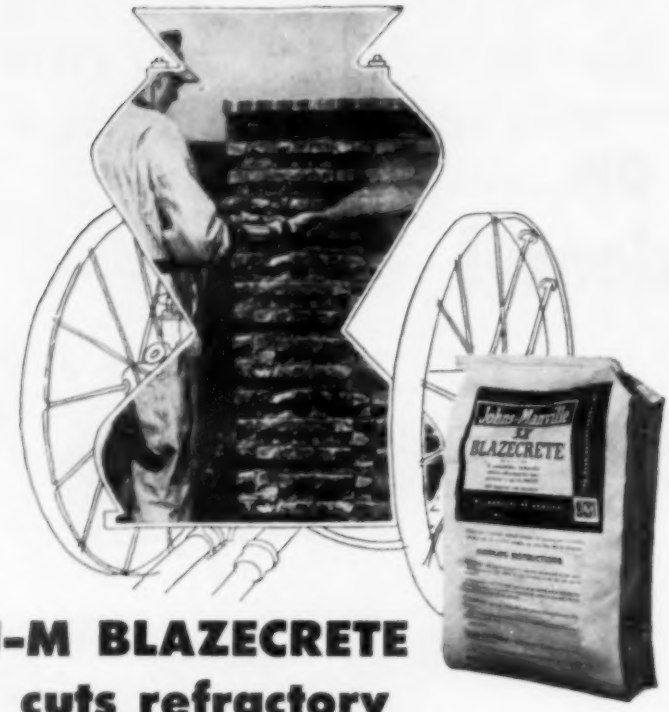

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FIG. 855

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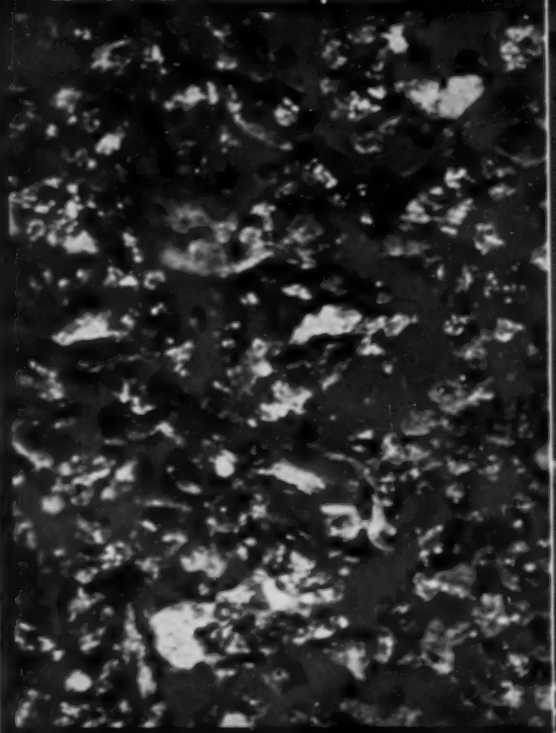
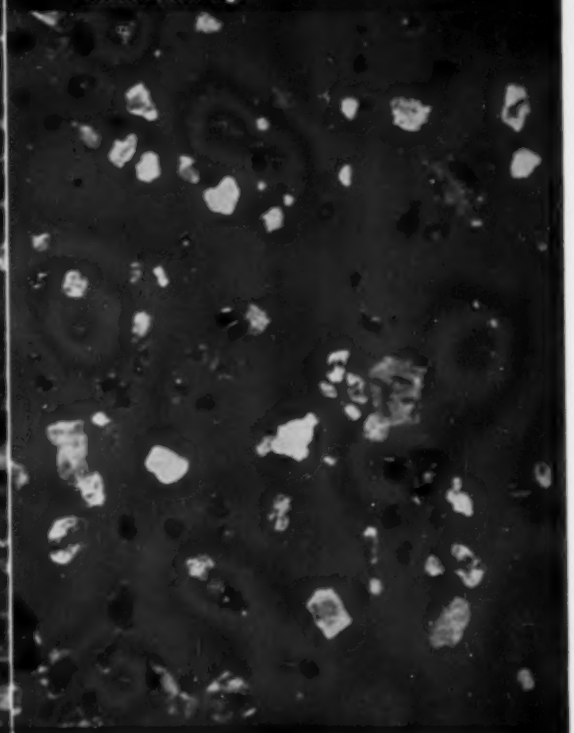
quantitative and qualitative PROOF

1. That "clean," ready-to-refine crude oil often contains harmful solids in substantial quantities.



The photomicrograph above (70X) shows the solids, or sediment, contained in about one half quart of supposedly "clean" refinery charging stock.

2. That they are effectively removed by PETRECO Electric Desalting.



This photomicrograph (also 70X) shows the sediment remaining in the same quantity of oil after it had been purified by Petreco Electric Desalting.

The removal of harmful solids from charging stock is an additional benefit derived from the use of Petreco desalting. In addition to removing 95% to 100% of the salts, Petreco desalting also insures against plugging and abrasion damage from solids such as those illustrated above. Along with the salts, these detrimental substances are brought together in the electric field, caused to associate with the water phase and are eliminated in the effluent water.

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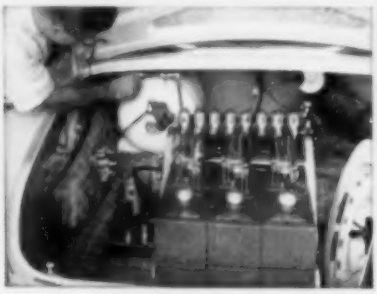
DS-6

The arrow is pointing to the Du Pont test car's fuel-injection pump, which is driven by the same shaft as the distributor.



From these tanks in the trunk, any of six different fuels can be selected for testing in the fuel-injection engine.

Fuel-injection car being tested on DuPont Petroleum Laboratory's chassis dynamometer.

Special DuPont test car studies advantages of *fuel-injection*

Will fuel-injection soon replace our standard carburetor system? As yet, no one knows the answer! But there are certainly many advantages to recommend it . . . such as freedom from carburetor icing, reduction of vapor lock troubles and improved power. And it will permit automobile styling changes since the hood lines can be lowered.

But how would a trend to fuel-injection engines affect the refiner? As a large supplier of the chemical additives used to improve fuel performance, we at Du Pont are interested in this development. And to study it thoroughly, the Du Pont Petroleum Laboratory is using a specially equipped test car.

The car has a Lincoln V-8 engine to which has been added an American Bosch fuel-injection system and special instrumentation. In addition to road work, the Petroleum Laboratory has tested the car on the Laboratory's chassis dynamometer.

From testing it with a variety of gasoline blends, the Laboratory has found that *fuel-injection permits greater flexibility in blending fuels. Fuel components with higher vapor pressures can be used, and it is possible that increases in the use of higher end point fuels may be practical. These wider tolerances could result in significant economic advantages to refiners,* as well as welcome benefits to the motoring public.

The Du Pont Petroleum Chemicals Division now has this car on a demonstration tour throughout the United States.

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By Peter J. Gaylor, Patent Attorney, Elizabeth, N. J.

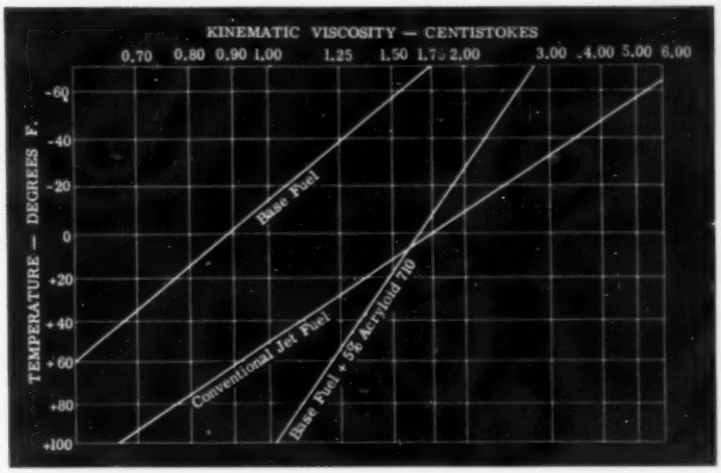

Fig. 1—EXTREMES IN VISCOSITY of aviation fuel, caused by the wide range of temperature encountered in jet flying, can be narrowed by addition of viscosity index improvers, as the performance of the base fuel plus additive shows

Viscosity Index Additives Improve Spray Performance of Jet Fuels

IN PRESENT day operation of jet-powered aircraft at altitudes up to and including 35,000 ft., a wide range of atmospheric temperatures are encountered. Although near the earth's surface the temperature may be 100° F. or higher, the temperature at high altitudes may be as low as — 67° F. Obviously, jet engines cannot be expected to operate with the present fuels and give high performance and efficiency throughout this wide range of operating temperatures.

Jet engine fuels, which generally comprise a distillate hydrocarbon petroleum oil boiling within the range of light gasoline to heavy gas oil inclusive, show the same general viscosity-temperature behavior of lubricating oils. In the Fig. 1 is shown the relationship between the kinematic viscosity and temperature for a conventional jet fuel and a base fuel such as aviation gasoline of 81.2 octane number. It is obvious that temperature does have a substantial effect on the viscosity of jet fuels as these two fuels clearly exemplify.

In the usual jet engine, the fuel is forced under pressure through a nozzle to be atomized into a fine spray and burned in the combustion chamber of the engine, thereby furnishing thrust to the aircraft. Before combustion of the droplets of spray in the combustion chamber, the fuel must be substantially vaporized to form a combustible mixture of fuel and air and possible combustion difficulties are encountered if the fuels are vaporized either too slowly or too rapidly. For instance, if all the fuel were to be vaporized quickly and mixed rapidly with the air, zones of gas would be created where the fuel-air mixture would be too rich to support combustion. As these gases are swept toward the exhaust of the combustion chamber, some dilution of the mixture with air may occur to give a combustible mixture; however, there usually is insufficient time for complete combustion before the reaction is quenched by the cooling air and swept completely out of the combustion chamber. If vaporization is insufficient then the mixture will be too lean to support combustion.

U. S. Patent No. 2,712,726, issued to Phillips Petroleum Co., covers a method for improving the viscosity index of jet fuels by admixture with the conventional jet fuels of from 2 wt.-% to 7 wt.-% of an oil-soluble, high molecular weight polymeric material, such as one of the commercial viscosity index improvers, Acryloid 710, Paratone, or Santodex. The object is to raise the viscosity index of the fuel and thereby improve its spray characteristics. This achieves easier starting of the engine, improved flame-out performance, and improved combustion efficiencies both on the ground and at high altitude and over a wide range of atmospheric temperatures, according to the patent.

The combustion of the fuel-air mixture depends upon the character of the spray introduced into the combustion chamber. Low-viscosity fuels require substantially lower fuel pressures than high-viscosity fuels to obtain a proper spray pattern, because spray quality is greatly influenced by fuel viscosity, to the detriment of the more viscous fuels.

The performance of fuels in starting and flame-out tests declines in the order of increasing viscosity of the fuel to the extent that at low fuel pressures the high-viscosity fuel is discharged with little or no atomization. According to the patent, small amounts of various polymeric substances of high molecular weight in admixture with standard types of hydrocarbon jet fuels substantially decrease the effect of temperature change on fuel viscosity and, therefore, cause an improvement in the viscosity index of the fuel. When the addition of a viscosity index improver to a fuel increases the viscosity of the fuel, nozzles designed for the use of higher viscosity fuels can be used.

A considerable variety of oil-soluble materials have been found to have the property of increasing the viscosity index of lubricating oils. At least three of these additives exhibit this property when admixed with the conventional jet fuels, which, of course, are not lubricating oils. Acryloid 710 is a well known additive with the polymeric material being essentially an ester of methacrylic acid and higher fatty alcohols such as cetyl or lauryl alcohol.

Another additive which has been found to increase the viscosity index of jet fuels is Paratone. This additive contains a linear iso-butylene polymer.

Another which is useful as a viscosity index additive is Santodex. The active ingredient of this additive is considered to be a co-polymer product of styrene and olefins of 8 to 12 carbon atoms.

These viscosity index improvers are all characterized by molecules of large size and long chains. For instance, the molecular weight is apparently in the order of 5,000 to as high as 20,000 for the Acryloid improvers, 10,000 to 15,000 for the Paratone improvers, and several thousand for the Santodex improver. These additives are composed of some 20 to 50% of the actual

Table 1—Specification Tests of Three Viscosity Index Improvers

	Paratone	Acryloid 710	Santodex
Gravity, °API	28.3	27.0	25.9
Saybolt viscosity at 100°F., SUS	55,600	24,000	30,000
Saybolt viscosity at 210°F., SUS	3,180	3,200	1,900
Flash point, °F	435	400	350
Pour point, °F.	30	20	25
Color, ASTM	2	2	2.5

polymeric material dispersed in light mineral oil to facilitate handling and blending. The specification tests on these viscosity index improvers is given in Table 1.

In the patent, the additives are utilized in rather small amounts, ranging say from 1% to 12% of additive, the preferred amounts being 2 to 7% by weight of the fuel. In Fig. 1 is shown the reduction of the effect of temperature changes on fuel viscosity in the case of a base fuel of aviation gasoline, the specifications of which are given below:

Norwood bromine No., gm. Br/100 gm	1.1
Gravity, °API	70.2
ASTM distillation, °F.:	
IBP	109
10% rec	144
50% rec	182
90% rec	208
EP	262
Reid vapor pressure, psi	6.65
Aviation octane No.	81.2
TEL, ml./gal	0.42
Aniline No., °C	61
Viscosity @ 100° F., cs	0.49

In this example, 5% by weight of fuel of Acryloid 710 was admixed with the aviation gasoline and the viscosity of the base fuel plus additive compared with the viscosity of the base fuel. The figure shows that the value of the slope of the fuel plus additive is smaller than the slope of the base fuel alone and, therefore, the viscosity index of the base fuel plus additive has been improved.

It should also be noted that although the viscosity of the base fuel has been increased by the incorporation of the additive, the viscosity of the improved fuel near the middle of the temperature range is still comparable to the viscosity of the conventional jet fuel.

Furthermore, the viscosity index of the patented fuel is also higher than the viscosity index of the conventional jet fuels, since in the higher range of temperatures the viscosity of the improved fuel is greater than the conventional fuel and in the lower range of temperatures the viscosity of the improved fuel is lower than the viscosity of the conventional fuel.

Therefore, the effect of temperature changes on the viscosity of jet engine fuels can be reduced by the addition of viscosity index improvers to obtain improved jet engine performance throughout a wide range of altitude conditions.

No doubt it is likely that such thickeners would have advantages in carburetor engine fuels. However, it is apparent that they would be impractical because of the non-volatile nature of the thickeners, so that they would accumulate in the vaporization zone of the carburetor.

Patents Issued Recently

The following classified listing gives the patent number, patentee, or assignees, and a brief description of all patents believed to be of interest to the petroleum processing industries, as contained in the Official Gazette of the U. S. Patent Office for August 30, September 6, 13, 20, and 27, 1955, Vols. 697 and 698, Nos. 5 and 1-4.

PROCESSES

Refining

2,716,332 (Koppers Company, Inc.) Systems for separating nitrogen from natural gas.

2,717,202 (National Cylinder Gas Co.) Counterflow liquid-gas contact apparatus.

2,717,229 (Phillips Petroleum Co.) Solvent extraction process for recovering aromatic gasoline.

2,717,231 (The American Oil Co.) Process for treating aromatic-diolefin mixtures in space above catalyst in hydroformer.

2,717,826 (Universal Oil Products Co.) Stabilization of hydrocarbon distillates with S-benzyl isothiourea.

2,717,854 (Esso Research & Engineering Co.) Countercurrent extraction tower and method of extracting hydrocarbon oil with phenol.

2,717,855 (Esso Research & Engineering Co.) Hydrodesulfurization of heavy oils.

2,717,856 (Esso Research & Engineering Co.) Heating oil processing for improved quality, involving mixing caustic-washed, air-contacted, cat-cracked naphtha with partially copper sweetened naphtha.

2,717,857 (Esso Research & Engineering Co.) Method for manufacturing heating oil by hydrofining.

2,717,858 (Esso Research & Engineering Co.) Heating oil blends incorporating hydrofined product.

2,717,859 (Standard Oil Co.-Ind.) Acid refining of heater oil.

2,717,861 (Esso Research & Engineering Co.) Selective naphtha hydrogenation process for olefins and diolefins.

2,717,864 (Esso Research & Engineering Co.) Partial hydrogenation of feed oils employed in catalytic cracking to produce motor fuels, by hydrogenation of at least 4 condensed rings per molecule.

2,718,453 (John W. Beckman) Method for reducing sulfur compounds from flue gases by blowing therein a finely divided solid calcium carbonate.

2,718,454 (Esso Research & Engineering Co.) Recovery of acidic gases with ethanolamine containing caustic, etc.

2,718,489 (Socony Mobil Oil Co., Inc.) Activation of ion exchange material and process for sweetening petroleum therewith.

2,718,490 (The British Petroleum Co. Ltd.) Catalytic desulfurization autofining of gas oil using Co-Mo oxide catalyst containing F.

2,718,492 (Esso Research & Engineering Co.) Benzene purification from mixed feed stocks by extractive distillation with phenol.

2,719,105 (Esso Research & Engineering Co.) Process for the production of high quality heating oil blends, using isopropanol-methanol solvent extraction.

2,719,106 (The British Petroleum Co., Ltd.) Extractive crystallization processes by means of urea.

2,719,107 (Phillips Petroleum Co.) Removal by means of pebbles of asphalt deposited during propane fractionation of lubricating oils.

2,719,108 (The British Petroleum Co. Ltd.) Catalytic desulfurization of petroleum hydrocarbons in presence of hydrogen and catalyst.

2,719,109 (Socony Mobil Oil Co.) Regeneration of aqueous alkaline solutions by raising to 44° Be density to remove top layer.

2,719,110 (Tide Water Associated Oil Co.) Refining cat cracked naphthas containing diolefins and pyrroles, using molten KOH.

2,719,145 (The Texas Co.) Process for effecting complex formation with urea.

2,719,206 (Phillips Petroleum Co.) Continuous adsorption apparatus.

Conversions

2,716,575 (Esso Research & Engineering Co.) Constriction valve for fluidized solids.

2,716,587 (Esso Research & Engineering Co.) Process and apparatus (Subway grating) for contacting solids and vapors in fluidized solids system.

2,717,230 (Universal Oil Products Co.) Catalytic reforming of hydrocarbon charge stocks high in nitrogen compounds by first contacting in presence of hydrogen.

2,717,439 (Socony Mobil Oil Co.) Method of erecting hydrocarbon conversion apparatus.

2,717,458 (Houdry Process Corp.) Apparatus for treating granular material with a gaseous material.

2,717,694 (Standard Oil Co.-Ind.) Elutriation of fines from powdered fluidized solids having agglomerating tendencies.

2,717,810 (Union Oil Co. of Calif.) Granular solids conveyance process and apparatus.

2,717,811 (Socony Mobil Oil Co.) Hydrocarbon conversion apparatus (separating granular contact material).

2,717,860 (Esso Research & Engineering Co.) Process for hydrofining and hydroforming hydrocarbons.

2,717,862 (Esso Research & Engineering Co.) Coking of hydrocarbon oils, using fluidized bed.

2,717,863 (Socony Mobil Oil Co.) Method and apparatus for conversion, using moving granular catalyst.

2,717,865 (Esso Research & Engineering Co.) Coking of heavy hydrocarbonaceous residues after previous boiling with naphtha.

2,717,866 (Esso Research & Engineering Co.) Hydrocarbon conversion of reduced crudes in the presence of coke particles.

2,717,867 (The M. W. Kellogg Co.) Hydrocarbon coking conversion, using bed of finely divided hot coke.

2,717,869 (Esso Research & Engineering Co.) Distillation of oil bearing minerals (oil shale).

2,717,888 (Standard Oil Co.-Ind.) Nickel oxide and alkali hydride catalyst for ethylene polymerization.

2,717,889 (Standard Oil Co.-Ind.) Polymerization of ethylene with a nickel-oxide and metal borohydride catalyst.

2,717,913 (Esso Research & Engineering Co.) Separation method for olefin alkylation in presence of acid catalyst.

2,718,339 (Phillips Petroleum Co.) Flow controller for mass of solid subdivided material.

2,718,491 (Shell Development Co.) Catalytic conversion of hydrocarbon oil using finely divided solid catalyst in fluidized condition.

2,718,535 (Gulf Research & Development Co.) Hydroisomerization of hydrocarbons in presence of Mo oxide.

2,719,111 (Esso Research & Engineering Co.) Catalytic reforming in fluidized bed of carbon particles.

2,719,112 (Esso Research & Engineering Co.) Contacting gases with fluidized subdivided solids.

2,719,113 (Universal Oil Products Co.) Hydrocarbon conversion with molten sulfide catalysts.

2,719,114 (Universal Oil Products Co.) Cracking and coking of heavy hydrocarbon oils in the presence of subdivided material.

2,719,115 (Sinclair Refining Co.) Method of coking hydrocarbon oils, using a body of coke particles.

Hydrocarbon Synthesis

2,716,596 (Du Pont Co.) Preparation of carbon monoxide and hydrogen by partial oxidation of carbonaceous solids.

2,717,259 (Union Carbide & Carbon Corp.) Hydrocarbon synthesis employing an iron catalyst in

the presence of a halogen-containing regulator.
2,717,260 (Union Carbide & Carbon Corp.) Hydrocarbon synthesis, incorporating sulfur in iron catalyst.
2,719,130 (Phillips Petroleum Co.) Synthesis gas manufacture (Fischer-Tropsch).

PRODUCTS

Chemicals

2,716,641 (Shell Development Co.) Process of polymerizing vinylidene compounds with peroxy water soluble catalyst.
2,716,661 (Esso Research & Engineering Co.) Recovery and upgrading of naphthenic acids by contacting naphthenate with organic solvent.
2,716,662 (Esso Research & Engineering Co.) Polycyclic dibasic acids (disodium dicyclopentadienyl).
2,716,664 (The Distillers Company Ltd.) Removal of selenium in aldehyde manufacture.
2,716,665 (The Distillers Company Ltd.) Manufacture of unsaturated aldehydes, using selenium and oxygen.
2,717,199 (Ethyl Corp.) Hydrogen chloride recovery.
2,717,200-1 (M. W. Kellogg Co.) Manufacture of hydrazine.
2,717,233 (Ethyl Corp.) Separation of gamma benzene hexachloride by distillation.
2,717,243 (Universal Oil Products Co.) Non-caking alkyl aryl sulfonate detergent compositions.
2,717,248 (Shell Development Co.) Polymerization of vinyl chloride with monopermalonate catalyst.
2,717,264 (Shell Development Co.) Process for decomposing 1-alkylcyclohexyl hydroperoxides.
2,717,265 (Sun Oil Co.) Sulfonation of mineral oil.
2,717,269 (The British Petroleum Co. Ltd.) Recovery of meta-2-xylidine.
2,717,272 (Ethyl Corp.) Treatment of benzene hexachloride.
2,717,880 (Shell Development Co.) Alkyl phenol emulsions and process for preparing the same.
2,718,456 (Shell Development Co.) Hexafluorophosphoric acid compositions and preparation thereof.
2,718,457 (Union Oil Co. of Calif.) Production of hydrogen cyanide from hydrocarbon, oxygen and ammonia.
2,718,458 (Socony Mobil Oil Co., Inc.) Method and apparatus for preparing finely divided anhydrous alkali metal hydroxides.
2,718,526 (Universal Oil Products Co.) Production of alkyl aromatic sulfonic acids and the alkylate therefor.
2,718,529 (Shell Development Co.) Hydroxylation of unsaturated aldehydes.
2,718,532-3 (American Cyanamid Co.) Reaction of acetylene with alkyl substituted benzenes to produce paraffin.
2,718,534 (Wulff Process Co.) Process for producing acetylene, using combustion.
2,718,596 (Esso Research & Engineering Co.) Alignment apparatus for source of ions.
2,718,597 (Esso Research & Engineering Co.) Infrared analysis apparatus.
2,719,010 (Sinclair Refining Co.) Process of preparing finely divided products from inorganic relatively porous plastic material.
2,719,131 (Du Pont Co.) Production of p-xylene polymers.
2,719,139 (Phillips Petroleum Co.) Polyvinyl chloride-polysulfone resin compositions.
2,719,142 (Shell Development Co.) Process for polymerizing polyethylenically unsaturated compounds in an aqueous medium.
2,719,143 (Shell Development Co.) Process for polymerizing unsaturated compounds in an aqueous medium.
2,719,163 (Esso Research & Engineering Co.) Ammonia treatment of synthetic drying oils to increase viscosity.
2,719,164 (Universal Oil Products Co.) Modification of drying oils.
2,719,171 (Du Pont Co.) Oxidative dehydrogenation process in presence of iodine.
2,719,180 (Ruhrchemie Aktiengesellschaft) Separation of alcohols from a carbon monoxide hydrogenation product.
2,719,183 (Houdry Process Corp.) Isomerization of xylenes.
2,719,184 (Badische Anilin- & Soda-Fabrik Aktiengesellschaft) Production of acetylene by incomplete combustion of hydrocarbons.

Fuels

2,716,597 (Koppers Company) Method and apparatus for the production of combustible gases from liquid fuels, using oxygen-containing gas.
2,716,628 (Esso Research & Engineering Co.) Desulfurization of petroleum coke by heat soaking in methane and cooling in oxygen-containing gas.
2,717,206 (Ethyl Corp.) Method for preparation of lead-sodium alloys.
2,717,493 (Don G. Fike) Liquid petroleum gas tank agitator.
2,717,868 (Pittsburgh Consolidation Coal Co.) Desulfurization of low temperature carbonization char with hydrogen and methane.
2,718,753 (Phillips Petroleum Co.) Improved operation of internal combustion engine operating on liquid petroleum gas fuel.
2,718,754 (Esso Research & Engineering Co.) Combustion system for combustion gas turbines, using preheated recycle exhaust gas.
2,718,883 (The Texas Co.) Ignition systems in pressure fuel injection units.

Lubricants

2,717,2a1 (American Cyanamid Co.) Tall oil-pitch-phosphorous sulfide reaction product and metallic salts as dispersants for lubricating oils.
2,717,242 (California Research Corp.) Polyoxyalkylene lubricant composition.
2,718,462 (Leonard Cohen) Aluminum soaps of mixed iso-octoic acids as gelling agents for liquid hydrocarbons.
2,718,499 (Elgin National Watch Co.) Lubricants containing ethers with multiple sulfur linkages.
2,718,501 (California Research Corp.) Oils stable against oxidation, containing sulfur compound and amine.
2,718,502 (Gulf Research & Development Co.) Lubricant compositions (glycerol ester, phosphatide, and hydrocarbon).
2,718,503 (Gulf Research & Development Co.) Anticorrosion agents consisting of the monamides of dimerized fatty acids.
2,718,504 (Esso Research & Engineering Co.) Oil solution of polymerized carbonate ester as pour inhibitor.
2,719,121 (Esso Research & Engineering Co.) Compounded mineral lubricant containing dialkyl phenothiazine and Zn or Mg naphthenate.
2,719,122 (Esso Research & Engineering Co.) Complex alkali metal soap-alkaline earth metal salt thickened grease composition.
2,719,123 (Robt. L. Merker, & Wm. A. Zisman) Fluid compositions containing a cyclopolysiloxane containing some metal soap.
2,719,124 (Esso Research & Engineering Co.) Grease compositions containing oxonated acid soaps.
2,719,125 (Standard Oil Company) Oleaginous compositions non-corrosive to silver containing 1,3,4-thiadiazole polysulfide.
2,719,126 (Standard Oil Company-Ind.) Corrosion inhibitors and compositions containing same (containing thiadiazole polysulfide).

Specialties

2,716,610 (Esso Research & Engineering Co.) Automobile polish compositions containing oil soluble sulfonate, etc.
2,716,611 (Esso Research & Engineering Co.) Rust preventive composition containing microcrystalline wax, ester, sorbitan, etc.
2,716,634 (Esso Research & Engineering Co.) Transparent rust preventive cutting oil composition containing oil soluble sulfonate, nitrite, etc.
2,717,196 (Shell Development Co.) Sheet wrapping material containing nitro-phenol compound.
2,717,658 (Phillips Petroleum Co.) Carbon black collecting and separating process and apparatus.
2,718,479 (Presque Isle Laboratories & Mfg.) Asphalt coated sheet.
2,718,480 (Sun Oil Co.) Method for cleaning internal combustion engines with hydrazine and boron hydride.
2,718,500 (Esso Research & Engineering Co.) Rust inhibited composition containing phosphoric ester, etc.
2,718,505 (Esso Research & Engineering Co.) Preparation of activated carbon from tar and sludge.
2,718,934 (C. A. Norgren Company) Oil fog generator.
2,719,135 (Philips Petroleum Co.) Recovery of carbon black.

Miscellaneous

2,716,914-5 (Gulf Research & Development Co.) Smoke suppressing system for use with machine tools.
2,716,997 (Esso Research & Engineering Co.) Quick release timing valve.
2,717,095 (Shell Development Co.) Drainage apparatus for movable roofs.
2,717,517 (Sun Oil Co.) Apparatus for measuring liquid contents of floating roof tanks.
2,717,765 (Paul Lawler, Jr.) Viscosimeter bath refrigeration unit.
2,718,305 (Socony Mobil Oil Co.) Separation of gel particles.
2,718,449 (Phillips Petroleum Co.) Pulse measuring apparatus.
2,718,460 (Oxy-Catalyst, Inc.) Catalytic assembly.
2,718,493 (Paul Lawler, Jr.) Distillation test apparatus.

EQUIPMENT

Processing, general

2,716,276 (Brown Fintube Co.) Method of bonding fins to tube.
2,716,330 (Westinghouse Electric Corp.) Combustion apparatus having primary air preheating ducts.
2,716,587 (Esso Research & Development Co.) Process and apparatus for contacting vapors and solids.
2,716,597 (Koppers Co.) Method and apparatus for producing combustible gases from liquid fuels.
2,716,802 (Tranter Manufacturing) Method of making heat exchange devices.
2,716,859 (Reliance Electric & Engineering Co.) Heat exchanger.
2,717,051 (Research Corp.) Apparatus for removing suspended materials from gas streams.
2,717,081 (Maloney-Crawford Tank and Mfg. Co.) Emulsion treater pressure control.
2,717,202 (National Cylinder Gas Co.) Counterflow liquid-gas contact apparatus.
2,717,320 (Reliance Electric & Engineering Co.) Heat exchanger.
2,717,458 (Houdry Process Corp.) Apparatus for treating granular material.
2,717,493 (Don G. Fike) Liquid petroleum gas agitator.
2,717,658 (Phillips Petroleum Co.) Carbon black collecting and separating process and apparatus.
2,717,767 (Georges S. and Marguerite Cantacuzene) Heat exchanger.
2,717,811 (Socony Mobil Oil Co.) Hydrocarbon conversion apparatus.
2,717,854 (Esso Research & Engineering Co.) Countercurrent extraction tower and method of extracting hydrocarbon oil with phenol.
2,717,912 (Martin R. Kroger) Process and apparatus for purification of benzene.
2,718,215 (Blaw-Knox Co.) Apparatus for separating liquid from vapor in an evaporator.
2,718,216 (Lummus Co.) Fluid heater.
2,718,139 (Phillips Petroleum Co.) Flow controller.
2,718,982 (Shell Development Co.) Flow control system.
2,719,112 (Esso Research & Engineering Co.) Contacting gases with fluidized subdivided solids.
2,719,184 (Badische Anilin & Soda Fabrik A. G.) Apparatus for production of acetylene.

Catalytic Reactors

2,717,863 (Socony Mobil Oil Co.) Method and apparatus for catalytic conversion.
2,718,460 (Oxy-Catalyst Inc.) Catalytic assembly.
2,718,491 (Shell Development Co.) Catalytic conversion of hydrocarbon oil and apparatus.

Instruments

2,716,337 (Stamicarbon N.V.) Apparatus responsive to variations in the viscosity of a fluid.
2,716,341 (Esso Research & Engineering Co.) Tank depth and time recording mechanism.
2,716,342 (Wekaler Thermometer Corp.) Thermometer.
2,716,343 (Emil S. Wieszeck) Temperature indicating meter.
2,716,371 (General Electric Co.) Apparatus for measuring the saturation of solutions.
2,716,685 (General Motors Corp.) Variable resistor for liquid level telemetric system.
2,717,078 (McNally-Pittsburg Mfg. Corp.) Automatic density regulator.
2,717,517 (Sun Oil Co.) Apparatus for measuring liquid contents of floating roof tanks.
2,717,991 (Floyd A. Sherman) Fluid level indicator.
2,718,147 (John A. Wilson) Liquid level indicator.
2,718,241 (Taylor Instrument Cos.) Differential pressure responsive units.
2,718,780 (Western Electric Co.) Automatic pressure control and leakage detector.
2,718,784 (George U. Brake) Liquid level gage.
2,718,785 (Lorn L. Spencer, Sr.) Liquid level gage.
2,718,786 (Ohmart Corp.) Gaseous thermocouple temperature-measuring means.
2,718,787 (Frederick A. Shen) Liquid medium returning device for thermometers, etc.
2,719,196 (Galileo Wright) Liquid level indicating and signaling device.

Pumps & Compressors

Re 24,063 (Harry Sadler and Ernest E. Cook) Pump construction.
2,716,381 (Bendix Aviation Corp.) Reciprocating electromagnetic pump.
2,716,948 (Ernest A. Cuny) Rotary pump.
2,716,949 (Ridge Tool Co.) Reversible vane pump.
2,718,193 (McGraw Electric Co.) Motor-pump unit.
2,718,351 (General Electric Co.) Rotary pump.

Valves & Fittings

Re 24,055 (Lee G. Daniels) Multiple port valve.
2,716,394 (General Controls Co.) Pilot controlled diaphragm valve with follow-up.
2,716,418 (International Harvester Co.) Thermostatic drain valve.
2,716,419 (C. M. Kemp Mfg. Co.) Fire check.
2,716,421 (Hydropress Inc.) Valve seat retaining

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McGRAW-HILL PUBLICATIONS

Patents

and removal means.
2,716,425 (Hydro-Aire Inc.) Pilot operated valve.
2,716,426 (Saunders Valves Co. Ltd.) Means for actuating valves or other devices.
2,716,506 (L. L. Fike Metal Products Co.) Rupture disc assembly for high pressure vessels.
2,716,544 (William M. Exley, Jr., and Arthur Howe) Mixing valve.
2,716,575 (Esso Research & Engineering Co.) Constriction valve for fluidized solids.
2,716,997 (Esso Research & Engineering) Quick release timing valve.
2,717,001 (Ainslie Perrault) Valve seat.
2,717,003 (Chloride Electrical Storage Co. Ltd.) Double seat or equilibrium valves.
2,717,004 (Page Oil Tools Inc.) Multiple valve.
2,717,112 (John D. Ralston) Fluid flow precise shut-off valve.
2,717,758 (Walworth Co.) Plug valves.
2,717,759 (Koppers Co.) Valve operating mechanism.
2,718,234 (Benjamin J. Blumberg) Hygroscopic air escape valve.
2,718,237 (John L. Matasovic) High pressure valve assembly.
2,718,371 (Edward W. Erdman) Throttling gate valve.
2,718,372 (Albert F. Broz) Gate valve.
2,718,373 (Guy J. Henry) Valve construction.
2,718,437 (International Harvester Co.) Fluid pressure control valve.
2,718,898 (Walworth Co.) Valves.
2,718,900 (Irvin E. Nutter) Valve mechanism for fluid and liquid contact apparatus.
2,719,022 (Orbit Valve Co.) Valves.

Miscellaneous

2,716,280 (Ralph Ruhe) Chain type pipe cutter.
2,716,282 (Carl B. Kromsten) Gasket cutter.
2,716,428 (Samuel Pennella) Leak stopper for condenser tubes.
2,716,873 (Secretary of the Navy) Resilient coupling.
2,717,094 (George A. Moore) Petroleum containers.
2,717,697 (Charles G. Viggers) Means for controlling the sludge flushing of a fluid treating plant.
2,717,848 (Jave Corp.) Pipe covering.
2,718,977 (John H. Wiggins) Weather roof for floating tank roofs.

ENGINEERS

Chemical and Oil Refining

Furnace Builder requires engineers with experience in design and operation of processing heaters used in petroleum and chemical industries—location New York. Salary, incentive plan and excellent working conditions. P-7835 —Petroleum Processing, 330 W. 42nd St., New York 36, N. Y.

Sperry Buys Inspection Firm

Non-destructive testing of a variety of oil refining equipment will be offered by Sperry Western, a recently acquired subsidiary of Sperry Products, Inc., and formerly known as Western Inspection, Inc.

Founded in 1949, the firm has been engaged in testing of tubular goods used in the oil industry. Sperry plans to add several new techniques, including ultrasonics, and to make the firm's services applicable to a wider range of oil refining and oil well equipment.

Sperry Western's board of directors include J. B. Earwell, chairman; J. H. Binford, R. B. Manning and D. W. Gordon.

ISA Picks Sheen for 1956

Robert T. Sheen, president of the Milton Roy Co., is the 1956 president of the Instrument Society of America. Mr. Sheen and his father founded the company in 1937 and Mr. Sheen went on to form the Chemical Pump and Equipment Corp. of New York City in 1948 and, with another person, the Chempump Corp. of Philadelphia in 1952. He has been president of Milton Roy since 1947 and of Chempump since 1952.

Mr. Sheen

He is a 1931 graduate of Lehigh College and holds a B. S. in chemical engineering. After his graduation he was employed by Monsanto Chemical Co. and as a consulting engineer for W. H. & L. D. Betz.

B-W Research Center Underway

Construction on the first unit of Borg-Warner's projected research center was begun recently at Des Plaines, Ill. The center will eventually contain facilities for research in metallurgy, electronics, electricity, chemistry, acoustics, hydraulics, applied mechanics, physics and nucleonics. There will also be a complete machine and model shop, a computation center, and a large technical reference library. The center is being constructed on a 36½-acre site.

The emphasis at the Des Plaines laboratory will be on long-range research and development, the latter being facilitated by an advanced engineering and design section to be included in the building. The first unit will contain about 40,000 sq. ft. of floor space, the final structure some 200,000 sq. ft. Each addition will be essentially in the form of a one-story unit stemming from the first, central unit. Construction of this first section is expected to be completed next spring, and its complement of personnel will include some 100 engineers and scientists.

FOUR BILLIONTH POUND of tetraethyl lead is in this tank-car of Ethyl Corp. anti-knock compound leaving the Baton Rouge plant for a West Coast refinery. C. W. Bond, right, general manager of manufacturing, and W. F. Armstrong, assistant general manager, are on hand. Over 520 billion gallons of gasoline have been improved with TEL, it is estimated, since introduction of the compound in 1923.

Dr. Bachman Made Koppers V-P

Dr. Paul Bachman, active in chemical research and development during the past 25 years, has been elected vice-president and director of research and development for Koppers Co., Inc.

Dr. Bachman has been with General Chemical Co., Victor Chemical Co., Commercial Solvents Corp., and Davison Chemical Co. With the last firm he became vice-president of research and development.

Dr. Bachman took his Ph.D. in chemistry at Johns Hopkins University in 1926, three years after receiving a B.S. in chemical engineering from the same school.

Warner Lewis Elects Fitzgerald

J. N. Fitzgerald became president of Warner Lewis Co. with the recent resignation of Warner Lewis from the post. Mr. Lewis has been elected chairman of the board.

Mr. Fitzgerald joined Warner Lewis in 1948 as its Washington representative and remained in that capacity as a vice-president of the company until January of 1954. At that time the company was acquired by the Fram Corp. as a wholly owned subsidiary, and Mr. Fitzgerald was moved to Tulsa as executive vice-president of the subsidiary.

B-W Acquires Byron Jackson

Byron Jackson Co., west coast manufacturer of pumps, oil tools, and electronic equipment, has been acquired by Borg-Warner Corp. and will operate as a division of the company.

E. S. Dulin, Byron Jackson president, has been appointed president of the Byron Jackson Division, and all officers of the firm have similarly transferred to the division.

Western to Represent Brown

Western Supply Co. will act as sales representatives for Brown Fintube Co. in the states of Kansas, Oklahoma and the urban and rural areas of Kansas City, Mo., under a recent agreement made by the two firms.

The arrangement is expected to provide experienced representation for Brown's line of heat transfer equipment and to "make possible certain areas of utilization of Fintubes in shell-and-tube exchangers," the two companies announced. Western has been employing finned surface to shell-and-

tube use, and E. D. Anderson, Western's chief engineer, will be active in the second phase of the companies' collaboration because of his earlier work at Brown Fintube.

Dr. Haensel

Dr. Bloch

Dr. Chenicek

Dr. Murray

New Research Directors at UOP

Four top-level personnel changes were made recently in the research and development laboratories of Universal Oil Products Co. Dr. Vladimir Haensel became director of refining research, and Dr. Herman S. Bloch was made deputy director. Dr. J. A. Chenicek was promoted to director of chemical research, and Dr. M. J. Murray to director of physics research.

The positions are new, the company announced, and were created to improve coordination of research functions and to permit broadening of company activities.

Personnel Changes

Macco Corp.—C. F. Van Loozen to the refinery and chemical division sales department. In the past he has been with Dresser Equipment Co., The Lummus Co. and Oil Well Supply Co.

Rockwell Mfg. Co. of Canada—Thomas P. Wall, former manager of the Toronto branch office of Peacock Bros. Ltd., to general manager of the company, a subsidiary of Rockwell Mfg. Co., Pittsburgh.

Cooper-Bessemer Corp.—Lawrence F. Williams to president, succeeding Gordon Lefebvre, who has resigned for reasons of health; James E. Brown, treasurer, has taken the additional post of secretary, to replace Mr. Williams.

Consolidated Engineering Corp.—Kennett W. Patrick to director of the transducer division, succeeding Walter B. Claus, who has been assigned to the manufacturing division on certain special projects. Patrick was formerly director of the system division, which is now directed by Harry E. Burke, Jr., who was assistant director.

ALCO Products, Inc.—Douglas B. Fraser to manager of the Cincinnati plant, acquired recently from Central Pipe Fabricating and Supply Co. The plant is used for manufacture of prefabricated pipe.

Edward Valves—Earl N. Stone to sales engineer for Colorado, Utah, western Kansas, Montana and Wyoming.

ElectroData Corp.—Ken Austin to manager of the new regional sales and service headquarters at 4515 Prentice St., Dallas.

Atlas Powder Co.—Thomas H. Sadler to the central research lab as a petroleum engineer.

Cooper-Bessemer Corp.—C. R. Jones to manager of western Canada for Cooper-Bessemer of Canada, Ltd.; John McKissick to branch manager of the Seattle office.

International Nickel Co.—C. Roger Sutton, formerly a metallurgist at the Argonne National Laboratory of the U. S. Atomic Energy Commission, to the development and research division as a member of the stainless steel and heat resistant alloys section.

Minneapolis-Honeywell Regulator Co.—C. L. Peterson to vice-president and general manager of the Brown Instruments Division. He was formerly divisional vice-president.

Robertshaw-Fulton Controls Co.—R. S. Reynolds, Jr., to chairman of the board, succeeding the late R. S. Reynolds, Sr.; J. Louis Reynolds and John A. Robertshaw, Jr., were appointed to fill board vacancies.

Rockwell Manufacturing Co.—Leopold Sweet, division engineer of the Instrument Division, to staff industrial engineering training supervisor in Pittsburgh; Donald C. Morgan, Chicago district sales manager, Meter and Valve Division, to central region sales manager of the division, with offices in Pittsburgh.

Catalytic Construction Co.—George F. Klein, Jr., to chief engineer. He was manager of the process engineering department.

Rhodia, Inc.—W. C. Mackie to technical sales representative for Pacific Coast customers of aromatic chemicals and "Alamask" industrial deodorants.

M. W. Kellogg Co.—Peter J. Manno and Christopher J. O'Shea to the catalysis section of the petroleum and chemical research laboratory. Both are recent Ph.D. graduates in physical chemistry from Purdue University.

Selas Corp. of America—William M. Smith, from New York City sales representative to sales division in the home office; William C. Schneider, leaves the Rochester, N. Y., territory to replace Mr. Smith in New York and north Jersey, with assistance from Gerald E. Mitchell; Kenneth E. Rasmussen replaces Mr. Schneider in Rochester; Harry E. Morton to sales representative in Chicago.

Gustin-Bacon Manufacturing Co.—F. W. Muller to manager of insulation sales, a new department. H. M. Grant is assistant manager and S. E. Brelsford is assistant to the manager.

"Soyez les Bienvenus à Montréal au Mois de Mai!"

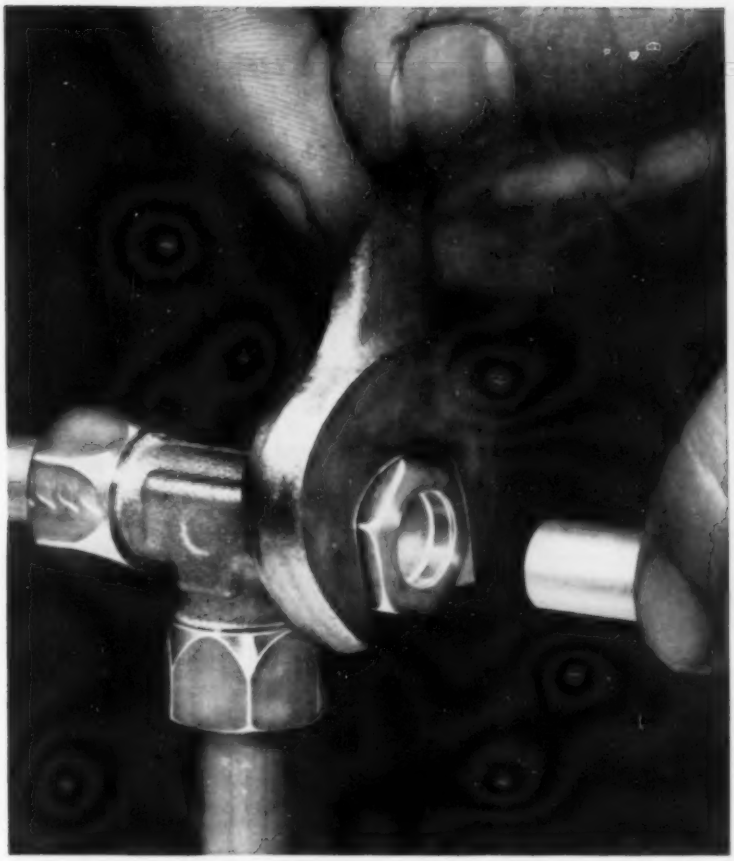
Branches, Distributors

Automatic Switch Co. has appointed Control Specialty Corp., Houston, as stocking distributor of its solenoid valves.

Hammel-Dahl Co. has opened a new sales office in Tulsa at 310 Thompson Bldg. Paule E. Bowles has been appointed district sales manager and will supervise the office.

Pacific Pumps, Inc., has opened a San Francisco office for centrifugal pump sales at 593 Market St. It is under the direction of Lee Watts, formerly of the Los Angeles District office.

Plibrico Co.'s refinery division has opened new headquarters at 55 W. 42nd St. in New York City. Manager of the refinery division, J. A. Knebel, takes the additional post of general manager of the new office.



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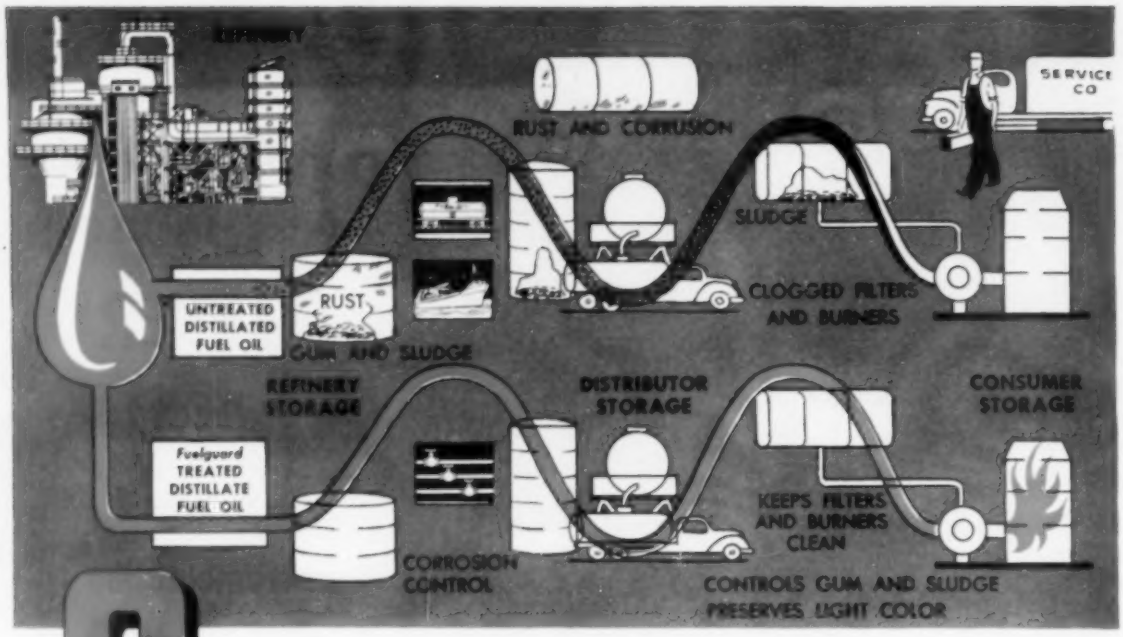

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3. FILTER PLUGGING TEST
measures the effect of sludge build-up on filter flow.

4. BREAK POINT TEST
measures the length of time for heavy sludge to form in fuel oils.

5. CORROSION TEST
evaluates the corrosion and rusting caused by the presence of water in fuel oil tanks and pipelines.

6. EMULSION TEST
determines the degree to which water is emulsified in fuel oil.

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Chem Engineers to Meet in Detroit

DETROIT, Mich., will be the site of the American Institute of Chemical Engineers' 48th annual meeting Nov. 27 to 30. Headquarters will be the Statler Hotel, and in addition to the usual technical sessions and social events there will be tours to some 17 industrial and research plants in the area.

On Monday, Nov. 28, technical papers of special interest will be as follows:

"Single Phase Blending of Liquids," by E. A. Fox and V. E. Gex, Procter and Gamble Co.

"Agitation of Non-Newtonian Fluids," by A. B. Metzner and R. E. Otto, University of Delaware.

"Use of Electronic Analogs in Studies of Reaction Kinetics and Reactor Design," by J. A. Beutler and J. B. Roberts, du Pont Co.

"Rate Studies in Tubular Reactors," by H. E. Hoelscher and Eric Weger, Johns Hopkins University.

"The Rate of Nitration of Benzene with Mixed Acids," by R. D. Biggs and R. R. White, University of Michigan.

On Tuesday morning, technical session No. 5, a symposium on the standardization of centrifugal chemical pumps, will feature these papers:

"Mechanical Design of Centrifugal Pumps from Shaft Deflection Measurements," by D. S. Ullock, J. A. Reynolds and T. W. Hudson, Carbide and Carbon Chemicals Co.

"The Dimensional Standardization of Centrifugal Pumps," by D. C. Brand, Monsanto Chemical Co.

"Standardization of Centrifugal Chemical Pumps from the Viewpoint of the Manufacturer," by M. L. Murdock, Allis-Chalmers Manufacturing Co.

Technical session No. 9, on Wednesday morning, will offer among its papers:

"Performance of an Internally Baffled Multistage Extraction Column," by E. G. Scheibel, Hoffmann-LaRoche Inc.

Another event during the morning and afternoon is a symposium on mechanics of bubbles and drops, featuring the following papers:

"Formation of Bubbles at Submerged Orifices," by J. C. Bryan and H. J. Garber, University of Tennessee.

"Effect of Turbulence on Drop Size for an Oil-Water Dispersion," by P. H. Roy and J. H. Rushton, Illinois Institute of Technology.

"Light Transmittance as a Measure of Interfacial Area in Liquid-Liquid Dispersions," by Virgil G. Trice and Walton A. Rodger, Argonne National Laboratory.

"Effect of Wall Proximity on the Rate of Rise of Single Air Bubbles in a Quiescent Liquid," by Sieji Uno and R. C. Kintner, Illinois Institute of Technology.

"A New Technique for Drop-Size Distribution Determinations," by A. P. Roy Choudhury and W. F. Stevens, Northwestern Technological Institute.

"Bubble Studies for Single-Holed Perforated Plates," by A. I. Johnson, D. G. Robinson and C. P. Michellepsis, University of Toronto.

"Mechanism of Heat Transfer to Liquid Drops," by R. V. McDowell and J. E. Myers, Purdue University.

"Some Mass Transfer Effects Inside Drops in a Miniature Liquid-Liquid Spray Tower," by F. P. Pike, W. T. Withers, Jr., and K. O. Beatty, Jr., North Carolina State College.

Atomic Catalysis a Topic At Nuclear Congress

Research on atomic energy in catalysis and chemical reactions will be presented at one of the sessions of the Nuclear Engineering and Science Congress, to be given in the Cleveland, Ohio, Public Auditorium Dec. 12 to 16.

The meeting will be held in conjunction with the International Atomic Exposition, which is sponsored by the American Institute of Chemical Engineers and is to run from Dec. 10 to 16 at the same location.

The papers on catalysis and chemical reactions, scheduled for Tuesday, Dec. 13, are on these topics:

"Effect of Gamma Radiation on Aqueous Ethylene-oxygen Solutions," by Ernest J. Henley, Jane P. Schwartz and Wesley P. Schiffries, Columbia University.

"Rates of Chlorination of Aromatic Hydrocarbons in the Presence of Gamma Radiation," by David E. Harmer, Joseph J. Martin and Leigh C. Anderson, University of Michigan.

"Electrolytic Separation of Metallic Isotopes," by James H. Andrews, Ivan Ceresna, F. A. Rohrman, William Utlaut, University of Colorado.

"Use of Nuclear Radiation in Combustion Research," by Martin E. Gluckstein, Richard B. Morrison, and John V. Nehemias, University of Michigan.

The first three papers are being sponsored by the AIChE, the last one by the American Rocket Society.

How to Find Friends At API Meeting

If you want to look up friends or make business contacts while you are at the API convention in San Francisco, McGraw-Hill's petroleum publications have made it easier for you. Here are two ways you can go about it:

- Use the direct-wire phones that will be installed near the API registration booths at each of the convention hotels—Mark Hopkins, Fairmont, St. Francis, and Sheraton Palace. These phones will connect you, without your dialing, with our central information office, where special operators will tell you the hotel and room number of anyone who registers for the convention.
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Texas A. & M. to Repeat Instrument Symposium

For the 11th successive year Texas A. & M. College will present the symposium on Instrumentation for the Process Industries. The site will be as usual the university campus at College Station, and the event will take place from Jan. 25 to 27.

The customary emphasis of these meetings is on new developments in process instrumentation. Material is given on the level of practical engineering and is directed toward instrument, design, process and operating engineers.

Rooms in the Memorial Student Center have already been reserved for that period, but hotel and motel facilities are available in the area.

Papers for Refiners at ASME Annual Nov. 13-18

Papers on the petroleum industry, applied mechanics, instruments and regulators, and fuels will be highlights for the petroleum refiner at the annual meeting of the American Society of Mechanical Engineers. The event will be the society's Diamond Jubilee meeting and will be held in Chicago at the Congress, Sheraton-Blackstone and Conrad Hilton Hotels Nov. 13-18.

Papers of special interest on Monday, Nov. 14, are the following:

"The Solution of Multiple Branch Piping Flexibility Problems by Tensor Analysis," by John W. Soule, University Engineers & Constructors.

"Tensor Flexibility Analysis of Pipe Supporting Systems," by John W. Soule.

"Terminology of Process Control Valves," by W. D. Washburn, Allied Chemical & Dye Corp., and Russell Milham, Foxboro Instrument Co.

"Procedures for Evaluation of Control Valve Mechanical Characteristics," by John T. Ward, du Pont Co., and Otto Kneisel, Hammel-Dahl Co.

"Test Procedures for the Evaluation of

Control Valve Flow Performance," by C. M. Johnson, Fisher Governor Co., and J. M. Fallis, Standard Oil Co. (Ind.)

"Effects of Adjacent Piping Configurations on Control Valve Characteristic and Capacity," by Glenn F. Brockett, Fisher Governor Co., and W. J. L. Kennedy, Stone & Webster Engineering Corp.

"Procedures for Evaluating Dynamic Characteristics of Valve Operators," by Andrew Bremer, Shell Development Co.

"Use of Nonlinear Valve Characteristics in the Control of a Simple Blending Process," by J. Lowen Shearer, Massachusetts Institute of Technology.

Authors of these papers to be read in the Fuels (II) session were not identified:

"Upgrading Burner Performance of Distillate Fuel Oils by Hydrogen Treatment."

"Improvement of Distillate Fuels by Additives and Refining Techniques."

"Combustion Calculations for Dual Fuels."

On Friday, Nov. 18, there will be a session on petroleum, with these papers scheduled:

"A Review of Mechanical Engineering Progress in the Petroleum Industry," author unidentified.

"A Look Into the Future of Mechanical Engineering in the Petroleum Industry," by E. W. Jacobson, Gulf Research & Development Co.

NGAA Panhandle Meeting Scheduled for Dec. 2

The Natural Gasoline Assn. of America will present its Panhandle-Plains regional meeting Dec. 2 at the Herring Hotel in Amarillo, Texas.

In the morning session, among the papers will be:

"The Application of Automation in the Natural Gasoline Industry," by J. F. Smith, Minneapolis-Honeywell Regulator Co.

"What About Valves?" by Bryan P. Rowland, Lunkenheimer Co.

"Training of Operating and Maintenance Personnel," by Paul W. Taylor, Magnolia Petroleum Co.

25th Chemical Exposition To Show Over 500 Exhibits

A display of achievement in applied chemistry and chemical engineering will be open to inspection at the 25th Exposition of Chemical Industries, to be held in Philadelphia Dec. 5 to 9. More than 500 exhibits will fill the spaces of the Commercial Museum and Convention Hall and will include everything from models of complete processing plants to a line of industrial, aircraft, and miniature thermocouples.

Among the exhibits of special interest will be the following:

A thermistor-actuated remote indicating controller which combines the three operating modes "on-off," proportional control, and adjustable differential.

A group of miniature flow-control valves for automatic control of flow, pressure, temperature and level in pilot plants, or to meter minute quantities of additives in commercial-size installations.

ACS Meeting to Discuss Process Analyzers

A session on continuous process analyzers will be part of the southwest regional meeting of the American Chemical Society, Dec. 1-3, at the Shamrock-Hilton Hotel, Houston.

The session on process analyzers will take place on the morning of Friday, Dec. 2, and will include these papers:

"A Refractometer for Process Monitoring and Control," by Harold Sobcov and Henry Landsberg.

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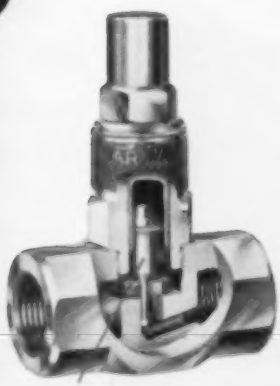

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Ultraviolet Analyzer," by Marshall S. Sparks, Raymond L. Kindred and D. E. Berger.

"Dielectric Constant Continuous Analyzers in Petroleum Refining," by N. F. Chamberlain, B. W. Thomas, J. B. Beaugh, and P. B. Land.

"Application of Spectrophotometric Analyzers to Process Streams," by Henry J. Noebles.

"Continuous Measurement of Water Content of Granular Materials by NMR," by T. M. Shaw, J. P. O'Meara, R. A. Garren, and W. R. Van Der Veer.

Managers Meet Hygienists At Conference Nov. 16-17

Management will meet the health profession to talk about industrial hygiene at the 20th annual meeting of the Industrial Hygiene Foundation. The meeting will take place at the Mellon Institute, Pittsburgh, on Nov. 16 and 17.

Some 700 persons in the industries and professions are expected at the discussions, which will deal with the medical, legal, engineering, chemical and toxicological phases of occupational health.

The meeting will include a medical conference, where management and industrial physicians will take up the problem of liaison between their respective functions, and a joint medical and chemical-toxicological conference, in which speakers will describe early signs of excessive exposure to toxic materials.

Oil Man's Calendar

NOVEMBER

Society of Automotive Engineers, golden anniversary fuels and lubrication meeting, Hotel Bellevue-Stratford, Philadelphia, Nov. 9-10.

American Society of Mechanical Engineers, annual Congress, Hilton and Sheraton-Blackstone Hotels, Chicago, Nov. 13-18.

National Assn. of Corrosion Engineers, Western Region, corrosion problems in the process industries, U. of California Extension Bldg., San Francisco, Nov. 14-17.

American Petroleum Institute, annual, Mark Hopkins, Fairmont, St. Francis, and Palace Hotels, San Francisco, Nov. 14-17.

2nd International Automation Exposition, Navy Pier, Chicago, Nov. 14-17.

Industrial Hygiene Foundation, annual, Mellon Institute, Pittsburgh, Nov. 16-17.

American Institute of Chemical Engineers, annual, Statler Hotel, Detroit, Nov. 27-30.

DECEMBER

Synthetic Organic Chemical Manufacturers Assn., annual dinner meeting, Commodore Hotel, New York, Dec. 1.

American Chemical Society, southwest meeting, Shamrock Hotel, Houston, Dec. 1-3.

Natural Gasoline Assn. of America, Panhandle-Plains meeting, Herring Hotel, Amarillo, Dec. 2.

25th Exposition of the Chemical Industries, Commercial Museum and Convention Hall, Philadelphia, Dec. 5-9.

Nuclear Engineering and Science Congress and International Atomic Exposition, Public Auditorium, Cleveland, Dec. 12-16.

JANUARY

Society of Automotive Engineers, annual, Sheraton-Cadillac and Statler Hotels, Detroit, Jan. 9-13.

7th Plant Maintenance and Engineering Conference and Show, Convention Hall, Philadelphia, Jan. 23-26.

Symposium on Instrumentation for the Process Industries, Texas A. & M., College Station, Jan. 25-27.

American Institute of Electrical Engineers, winter general meeting, New York, Jan. 30-Feb. 3.

FEBRUARY

Natural Gasoline Assn. of America, Permian Basin regional meeting, Lincoln Hotel, Odessa, Texas, Feb. 24.

American Institute of Chemical Engineers, Statler Hotel, Los Angeles, Feb. 26-29.

MARCH

National Assn. of Corrosion Engineers, annual corrosion conference, Statler Hotel, New York, Mar. 12-16.

Western Petroleum Refiners Assn., annual, Plaza Hotel, San Antonio, Mar. 19-21.

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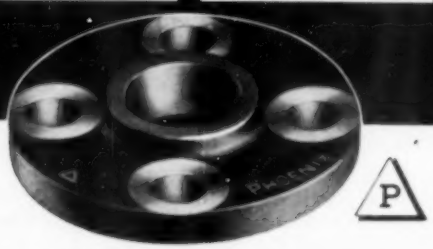

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New Data on Light Petroleum Gases

Some Properties of the Lighter Hydrocarbons, Hydrogen Sulfide, and Carbon Dioxide—Monograph on API Research Project 37, by Bruce H. Sage and William N. Lacey, 1955, 10¾ x 8¼ in., 250 pages, table of contents, illustrated, stiff cloth cover, $6.00 for API members, $10.00 for non-members. American Petroleum Institute, 50 W. 50th St., New York 20, N. Y.

ESTABLISHED in 1927 as part of the fundamental research program sponsored by the American Petroleum Institute, Project 37 has the objective of determining the behavior of the lighter hydrocarbons under conditions pertinent to the occurrence and production of petroleum.

Authors Sage and Lacey, professors of engineering at California Institute of Technology, have compiled in this monograph data resulting from a series of investigations conducted by API Research Project 37 during the period 1947 through 1953.

The new monograph is concerned mainly with the effect of pressure and temperature on molal volumes, and serves as a complement to the monograph issued in 1950 entitled *Thermodynamic Properties of the Lighter Hydrocarbons and Nitrogen*, also prepared by Professors Sage and Lacey.

Each of the twenty-two systems covered in the monograph include a brief discussion of the system, followed by specific system information in the form of graphs and tables. Approximately 170 literature references are cited throughout the monograph and in the bibliography.

Chemistry for Refining, Natural Gasoline, and Petrochemicals

The Chemistry of Petroleum Hydrocarbons, 3 volumes, edited by Benjamin T. Brooks, Cecil E. Boord, Stewart S. Kurtz and Louis Schmerling; 9¼ x 6¼ in.; Vol. I issued 1954, 672 pages, $18.00; Vol. II issued 1955, 448 pages, $13.50; Vol. III issued 1955, 690 pages, $18.00; indexed, illustrated, stiff cloth covers. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y.

An extensive and detailed coverage of petroleum hydrocarbon chemistry of interest to the petrochemical and natural gasoline producer as well as the refiner is available in these three volumes. Major emphasis is placed on the basic chemistry of the hydrocarbons themselves, but many industrial processes involving hydrocarbon chemistry are described.

The first volume contains 21 contributions covering: natural gas, gasoline, kerosine, gas oils, lubricating oils, petroleum waxes, types and origins of crudes, extractive and azeotropic distillation, selective adsorption, solvent extraction, separation of paraffins by urea and thiourea, physical properties and hydrocarbon structure, ultraviolet spectra, molecular structure and spectroscopic data, applications of infrared and Raman spectroscopy, mass spectroscopy, analysis and composition of the heavier petroleum fractions, preparation of pure paraffins and olefins, laboratory synthesis of low molecular weight alicyclic hydrocarbons and aromatic hydrocarbons, synthesis and purification of high molecular weight hydrocarbons and the Fischer-Tropsch process.

Volume II contains 16 chapters covering: mechanisms for thermal decomposition of hydrocarbons; results and conditions of thermal cracking of gasoline; composition of synthetic and cracked gasolines; acetylene by the pyrolysis of light hydrocarbons; pyrolytic reactions of aromatic hydrocarbons; theory and effects of variables in catalytic cracking; aromatization, hydroforming and platforming; catalytic dehydrogenation; mechanisms of the reactions of non-benzenoid hydrocarbons; theory of hydrocarbon oxidation; low-temperature oxidation of paraffin hydrocarbons; oxidation of paraffin wax; olefin autoxydation; synthesis gas from methane, oxygen and steam; partial oxidation of simple paraffinic hydrocarbons and special oxidation reactions of unsaturated hydrocarbons.

The final 22 chapters appear in Volume III and cover: oxidation of orthoxylene to phthalic anhydride; isomerization of saturated hydrocarbons; chlorination of paraffins and cycloparaffins, fluorination and properties of fluoro derivatives of paraffins and cycloparaffins; nitration of paraffins and cycloparaffins; special chemical reactions of paraffins and cycloparaffins; isomerization of olefins, vinyl polymerization; polyethylene; diels-alder condensations and related reactions; polymer gasoline; chemistry of natural and synthetic rubbers; condensation of saturated halides with olefins; catalytic hydrogenation of hydrocarbons; hydrogenation of cracked oils, catalytic naphtha, catalytic cycle stock and shale oil; oxo reaction; alkylation of saturated hydrocarbons; special olefin reactions; theory and mechanism of aromatic substitution; industrial applications of aromatic alkylation; sulfonation of aromatic hydrocarbons and the nitration of aromatic hydrocarbons.

The editors of the three volume series, *The Chemistry of Petroleum Hydrocarbons*, were B. T. Brooks, Consulting Chemist in New York City, C. E. Boord of Ohio State University, S. S. Kurtz of Sun Oil Co., and L. Schmerling of Universal Oil Products Co. Sixty contributors assisted these men in preparing the series.

Recent Books Briefly Noted

Studies of Thermal Conductivity of Liquids—Supplement to Part I, A Literature Survey of the Thermal Conductivity of Liquids, by Byron C. Sakiadis and Jesse Coates, 1954, 9 x 6 in., 24 pp., paper cover, $0.50. Engineering Experiment Station, Louisiana State University, Baton Rouge, La.

. . . the first addition to the Literature Survey of Thermal Conductivity of Liquids (Bulletin No. 34) published in 1952, presents the results of five recent investigations, and gives thermal conductivity values not available in 1952.

Consulting Services, 15th ed., 1955, 9 x 6 in., 144 pp., index, paper cover, $1, Association of Consulting Chemists and Chemical Engineers, Inc., 50 E. 41st St., New York 17, N. Y.

. . . consisting of three sections which respectively classify over 200 items of activity, give the scope of each member's qualifications and activities, and index alphabetically by members including names of organizations with which affiliated, geographical location, etc.

The Chemical Industry Facts Book, 2nd ed., 1955, 9 x 6 in., 160 pp., index, illustrated, paper cover, $1 (discount on bulk quantities), Manufacturing Chemists' Association, Inc., 1625 Eye St., N. W., Washington 6, D. C.

. . . contains 15 chapters ranging from "What the Chemical Industry Makes" to such specifics as "Chemicals in Health" and "Chemicals in Defense," prepared as an aid to editors, educators, and others requiring details or information about the chemical industry.

ASME Standard Industrial Engineering Terminology, 1955, 7¾ x 5¼ in., 48 pp., paper cover, $1.50, The American Society of Mechanical Engineers, Order Dept., 29 W. 39th St., New York 18, N. Y.

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sion's Word Standardization Committee which recognized the need for engineering standardization of terms; contains a definition of 500 industrial engineering phrases and terms.

ASTM Standards on Paint, Varnish, Lacquer, and Related Products, 9th ed., prepared by Committee D-1, Jan., 1955, 9 x 6 in., 868 pp., table of contents, illustrated, heavy paper cover, $6, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

. . . contains the latest review of more than 200 specifications, tests, and definitions, with 60 standards which have been approved by the Federation of Paint and Varnish Production Clubs.

Fatigue of Aluminum, by R. L. Templin, 1954, 9½ x 6 in., 59 pp., illustrated, $1.50, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

. . . contains the Gillette Memorial Lecture given at the 1954 annual meeting of the ASTM, discussing the fatigue of aluminum, the mechanism of fatigue failures, the evaluation of fatigue properties, factors affecting fatigue strength, etc., and having a bibliography of 49 references.

Management and Leadership, by Carl F. Braun, 2nd ed., 1954, 9 x 6¼ in., 287 pp., table of contents, cloth cover, $3.25 (discount for quantities of 12 or more), C. F. Braun & Co., Alhambra, Calif.

. . . one of a number of books written by Mr. Braun, *Management and Leadership* expresses the principles of leadership based upon Mr. Braun's many years of experience, avoiding the use of abstractions, academic language, or even high language so as to make it readily understandable to all ranks of leadership.

Supplemental Bibliography on Investment and Operating Costs for Petroleum and Petroleum and Chemical Plants, Bureau of Mines, IC—7705, by E. E. Harton and T. R. Tisot, Jan., 1955, 10½ x 8 in., 67 pp., table of contents, paper cover, Publications Distribution Section, U. S. Bureau of Mines, 4800 Forbes St., Pittsburgh 13, Pa.

. . . serves as a supplement to the Bureau of Mines Information Circular 7516, published Oct. 1949 and covering references and abstracts of publications appearing from 1930 to Sept. 1948, the new Information Circular covers the field from Sept. 1948 through June 1952, with information sources from 24 different publications.

Symposium on Permeability of Soils, STPP No. 163, 1955, 9 x 6 in., 142 pp., table of contents, illustrated, heavy paper cover, $3, American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.

. . . contains 11 papers presented at the 57th annual meeting of ASTM Committee D-18 on soils for engineering purposes, discusses the importance, evaluation, and control of factors encountered in the determination of soil permeability, compares permeability tests with descriptions and evaluation by formulas.

Light Scattering in Fuels, Part 1—Preliminary Studies on Diesel Fuel Stability, PB 111553, by J. E. Johnson, A. J. Chiantella, and H. W. Carhart, Sept., 1954, 10½ x 8 in., 13 pp., table of contents, illustrated, $0.50, Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C.

. . . discusses the development of apparatus and procedures to determine the formation of insoluble gum in diesel fuels as related to time and other valuables by measuring the light scattering properties of a variety of fuels.

Tentative Standard for Field Welding of Pipe Lines, API Standard 1104, third edition, 1955, $0.50, order from J. A. McNally, American Petroleum Institute, 50 West 50th St., New York 20, N. Y.

. . . incorporates changes from second edition on procedure qualification requirement and sketches of test specimens, prepared by a committee with representatives from the American Gas Assoc., Pipe Line Contractors Assoc., Pipe Manufacturers, American Welding Society, Society for Nondestructive Testing, and American Petroleum Institute.

Directory of Western Chemical Producers, compiled and edited by Stanford Research Institute in cooperation with Western Chemical Market Research Group, March, 1955, 8½ x 11 in., 100 pp., table of contents, paper cover, $5.00, Stanford Research Institute Chemical Economic Section, Stanford, Calif.

. . . listing of more than 475 chemical products manufactured by some 350 companies in about 450 western plants including Ariz., Calif., Colo., Idaho, Mont., Nev., N. M., Ore., Utah, Wash., Wyo., Alaska, Hawaii, Alberta, British Columbia and Saskatchewan — listing alphabetically both by producer and by product.

Biennial Report 1953 and 1954: National Bureau of Standards, Miscellaneous Publication 213, 1955, 162 pp., $0.60, order from Superintendent of Documents, U. S. Government Printing Office, Washington 25, D.C.

. . . report summarizing research and development activities in the physical sciences with brief descriptions of representative accomplishments in each area of Bureau's responsibility, including basic standards, determination of physical constants and properties of matter, development of methods and instruments of measurement, and the services of calibration, testing, and scientific advice.

Information Offered in the Advertisements

Do you need detailed information on a specific subject? Check through this easy-to-use index of literature and data being offered in this issue's advertisements.

ACTIVATED ALUMINA, for drying and as catalyst or carrier, samples and information; Alcoa Chemicals. See adv't. p. 1702.

ADDITIVE, fuel oil, ashless, booklet; Carlisle Chemical Works. See adv't. p. 1792.

ALUMINUM, for refinery fabrication, booklet and reprints; Alcoa Aluminum. See adv't. p. 1803.

ANALYZERS, automatic vapor phase chromatography, prices and information; Podbielniak, Inc. See adv't. p. 1758.

AUTOMATION, in petroleum refineries, booklet; M. W. Kellogg Co. See adv't. pp. 1690-1691.

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BUBBLE CAPS, 300 styles listed in catalog 22; Pressed Steel Co. See adv't. p. 1812.

CATALYSTS, tableted, booklet; Harshaw Chemical Co. See adv't. p. 1760.

CLEANING COMPOUNDS, for drums, tanks, etc., handbook; Oakite Products, Inc. See adv't. p. 1772.

COMBUSTION UNITS, oil-gas, vertical and horizontal, bulletin 498; National Airoil Burner Co., Inc. See adv't. p. 1818.

COMPRESSORS, gas, bulletin 75; Cooper-Bessemer Corp. See adv't. p. 1825.

CONDENSERS, and exchangers, bulletins on request; Condenser Service & Engineering Co. See adv't. p. 1806.

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EXPANSION JOINTS, chemical resistant, bulletin FC-952; U. S. Gasket Co. See adv't. p. 1782.

FABRICATION of heavy equipment, booklet describes facilities; Newport News Shipbuilding & Drydock Co. See adv't. p. 1774.

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GREASE KETTLES, catalog 356-R; Blaw-Knox Co. See adv't. p. 1811.

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INSULATION, industrial, pipe and molded block, folder; Philip Carey Mfg. Co. See adv't. p. 1771.

INSULATION, pipe, glass fiber, snaps on, bulletin; Gustin-Bacon Mfg. Co. See adv't. p. 1686.

JACKETED PIPE, for uniform temperature and batching, bulletins J-50 and F1-49; Hetherington & Berner, Inc. See adv't. p. 1812.

LIQUID SEPARATOR FILTER, for water removal, bulletin; Warner Lewis Co. See adv't. p. 1687.

MATERIALS HANDLING, truck containers, information; Ingersoll-Kalamazoo Div. See adv't. pp. 1682-1683.

METAL DEACTIVATOR, to control copper compounds, data and samples; Tretolite Co. See adv't. p. 1816B.

MIXERS, side and top entering, eight catalogs and data sheets; Mixing Equipment Co. See adv't. p. 1710.

PUMPS, proportioning, wide variety of sizes, catalog; Philadelphia Pump & Machinery Co. See adv't. pp. 1664-1665.

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REFRACTORY LININGS, hydraulic setting, for trowel or gun, brochure; Johns-Manville. See adv't. p. 1784.

REFRACTORIES, and porous mediums, bulletins 140, 458, 793 & 1741; The Norton Co. See adv't. pp. 1684-1685.

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VACUUM CLEANERS, explosion proof, for liquids and dry materials, information; Doyle Vacuum Cleaner Co. See adv't. p. 1780.

VALVE MAINTENANCE, new mobile field service, information; Rockwell-Nordstrom Valves. See adv't. pp. 1708-1709.

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ADVERTISERS' INDEX

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WHAT'S NEW...

Ultrasonic Flow Meter

Measures Mass or Volume Flow

Controlled sound waves are used to measure the flow of almost any liquid, for either volume or mass, in a new ultrasonic flowmeter. It is not affected by flow variables and offers virtually no pressure drop when installed in the pipe line.

The rate of volume flow is measured by two transducers, each of which transmits and receives controlled pulses of ultrasonic energy across a section of pipe. One is aimed upstream and the other downstream. An increase in the liquid flow rate increases the number of downstream pulses received and decreases the number of upstream pulses. Since the repetition rate of these pulses cancels out sonic velocity by heterodyne techniques, the difference in the number of impulses is proportional to the flow of velocity.

The addition of a third transducer can furnish density measurement, converting the instrument into a mass flowmeter. This compensates automatically for variations in density, permitting the same pipe to be used for different materials, with accurate control when switching to a new material.

It is claimed that this system eliminates the effect of temperature and density on flow measurement; as well as being unaffected by pressure, viscosity, gas bubbles, solids in suspension, and electrical conductivity variations.

Based on four years of development by the W. L. Maxson Corp. of New York City, the new flowmeter will be manufactured under license by Fischer & Porter. Available meters will have capacities up to 12,000 lb./min. with a fluid range of approximately 2.5 to 1. It can be adapted to standard pipe sizes down to 2 in. Standard operating conditions are: —50 to +225° F. and 150 to 300 psi. These conditions can be increased with special provisions. The flowmeter is made from steel, bronze, stainless or other material. Rangeability is 20:1 minimum, linearity is within 1 per cent full scale, and accuracy is better than 2% full scale. Fischer & Porter Co., Hatboro 35, Pa.

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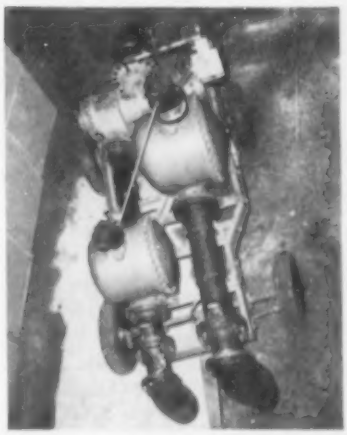
For More Information

Use one of the attached reply cards to request additional details or literature on any items reviewed in "What's New!" Just circle the numbers corresponding to the numbers at the end of each item in which you are interested. Then fill in the rest of the card and drop it in the mail. No postage is required.

Benzonitrile Available

. . . **in small quantities** for experimental purposes. Operating under a new process developed at Tennessee Products & Chemical Corp.'s research lab, a pilot plant is showing that commercial quantities can be produced at a cost permissible for its use in many industries. Direct requests for samples on company letterhead to: Tennessee Products & Chemical Corp., First American National Bank Bldg., Nashville 3, Tenn.



Portable Blender

. . . **for fuel oil** will blend two base stocks without external power. The line pressure of the flowing components operates a special blend valve, which both mixes and proportions in ratios from 50-50 to 95-5. Flow capacity is 2100 gpm. In the event of failure of either component stream the blender automatically stops the flow of the other stream. Mounted on a trailer, the blending unit can be moved to any desired location. It is designed for blending marine diesel fuels used in bunkering ships. Volumetric totals of each component is provided and form the basis for the mechanical control of blending. Proportioneers, Inc., Division of B-I-F Industries, Inc., 345 Harris Ave., Providence 1, R. I.

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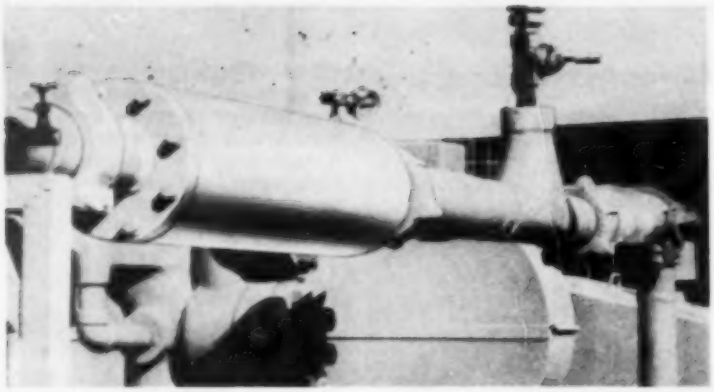

Pulsation Dampener

Small Size but High Efficiency

In production by Westinghouse Air Brake Co. is a new type of pulsation dampener, claimed to be twice as effective but to occupy only one-sixth the space of older type dampeners.

The heart of the new "Desurger" pulsation dampener is a rubber sleeve, working with throttling orifices that circle the main flow line. During pressure surges the sleeve is distended against a precharge of air, forcing liquid through the throttling orifices, thus dissipating the excess pressures.

The new dampener works against a maximum pressure of 2000 psi., and is designed to protect instruments, valves, fittings, and pipe against pressure surges and pulsations. The manufacturer also says that field tests have proved that the dampener will increase the flow capacity of lines by reducing the turbulences that retard smooth flow of liquids. Industrial Products Division, Westinghouse Air Brake Co., Wilmerding, Pa.

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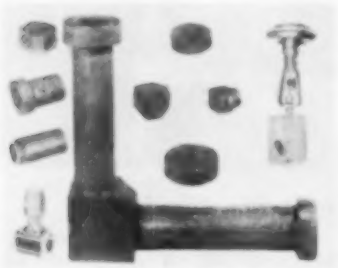

Armored Graphite Pipe

. . . **is now available** for corrosive liquids, and is designed to provide a substantial safety factor against breakage from physical shock. Standard "Impervite" pipe (of resin impregnated impervious graphite) is wrapped with fiberglas cloth that is saturated with a chemically resistant thermosetting plastic. It is then cycle-baked to form a tough, one-piece jacket, which is bonded well to the pipe. This jacket is also available on "Impervite" fittings, valves and can be applied to heat exchanger shells and tower sections of the same material. The pipe is suitable for operations at 75 psi. hydrostatic or 50 psi. steam, and temperatures to 340° F. Falls Industries, Inc., Aurora Road, Solon, Ohio.

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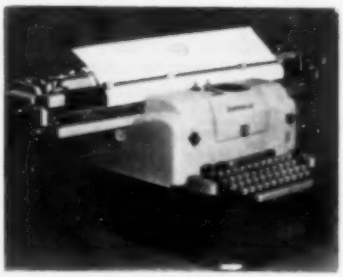

Data Readout

. . . **can be obtained by converting** a standard office electric typewriter to an automatic data reduction device. The typewriter is mounted on a special control base containing solenoid-operated tapper bars which actuate the selected letter and numeral keys. The present system permits remote operation of numerals "0" through "9," selected letters, and the tabulator, space, carriage return and ribbon shift controls. The unit will sell for approximately $1200; an optional tape punch attachment for about $600 extra. Fischer & Porter Co., Hatboro 35, Pa.

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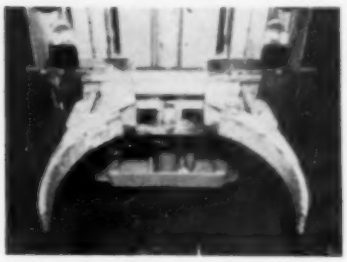

Crab Attachment

. . . **for drum handling** will fit all lift trucks. The unit permits the arms to grab, hold and release drums or containers without the use of power. Designed on an engineering principle that takes advantage of gravity, the unit is completely automatic and controlled by the truck operator. Kughler Development Corp., 230 Park Ave., New York City.

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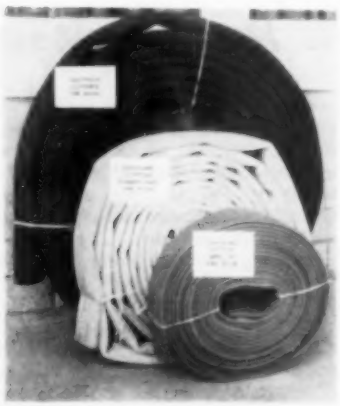
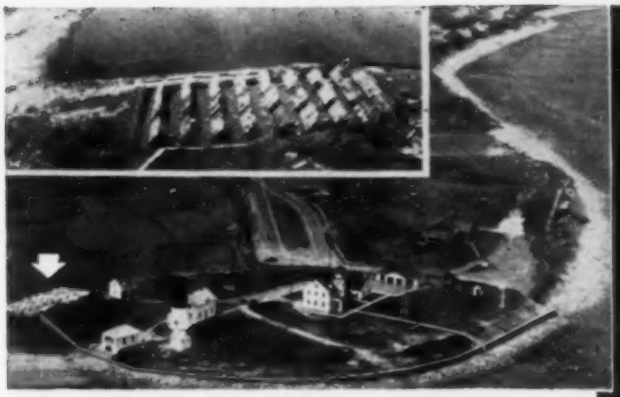


Light Weight Hose

. . . **is stronger, more compact,** and will coil into a much smaller diameter. It is also stronger and has greater flexibility than the conventional fire hose. Rated bursting pressure is 1000 psi. in the 1-in. size and 700 psi. in the 1½-in. size. The outer surface of the hose jacket is impregnated with neoprene, and processed with a mildew deterrent. Goodall Rubber Co. of Texas, 3550 West 12th St., Houston, Texas.

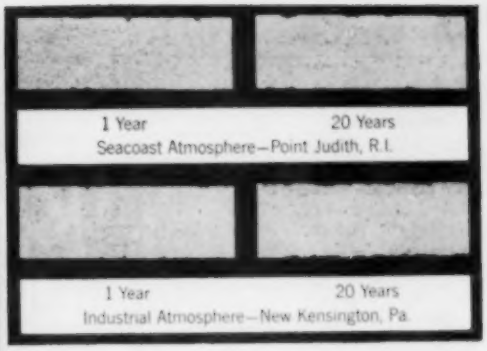
Circle No. 7 on Reply Card



POINT JUDITH, RHODE ISLAND

Aerial view and close-up (inset) of ALCOA'S seacoast exposure station at Point Judith. The station is located on a stony beach about 300 feet from the water's edge. Test specimens face south into prevailing winds from the ocean. Corrosion conditions are considered severe. [Aerial photo—courtesy of Providence (R.I.) Sunday Journal.]

There are other seacoast exposure stations at Wilmington, N.C.; Miami, Fla.; Golden Gate, Calif.; Georgetown, Br. Guiana; Pitcairn Island, Br. Oceania; and La Jolla, Calif.



Micrographs of full cross sections of 0.064-inch thick sheet of alloy 3003 after exposures indicated. Note that the corrosion develops at isolated spots, slowly spreads to new sites but is not appreciably deeper after 20 years than after one year. This pattern is typical for other corrosion-resistant ALCOA Aluminum alloys, such as 3004, 5050, 5052, 5154 and 6061.

20-year exposures prove ALCOA Aluminum resists weathering

During the past 25 years, ALCOA research laboratories have exposed many thousands of ALCOA Aluminum alloy specimens to atmospheres in many localities in this and other countries. One of the initial comprehensive investigations, started 20 years ago, involved exposure of approximately 25,000 individual test specimens. These and subsequent investigations on newer alloys are now sufficiently inclusive to demonstrate convincingly the superior weathering characteristics of ALCOA Aluminum when subjected to a wide variety of conditions, including industrial, seacoast and tropical environments.

ALCOA's coordinated research and development program is geared to help you with *your* specific problem . . . to show you where and how ALCOA Aluminum can be used most effectively in your operation.

Write today for all the facts. They're in the new, FREE double reprint, *Resistance of Aluminum Alloys to Weathering* and *Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*. Use the coupon below to obtain your copy. We also have a new booklet, *Aluminum Pipe and Fittings*. Send for it.

NEW KENSINGTON, PENNSYLVANIA

Atmospheric exposure racks are located on the roof of the Aluminum Research Laboratories near laboratory exhaust vents. The atmosphere is similar to that at Pittsburgh, Pennsylvania. There are other industrial exposure stations at Edgewater, N.J., and St. Louis, Mo.

ALCOA ALUMINUM
ALUMINUM COMPANY OF AMERICA

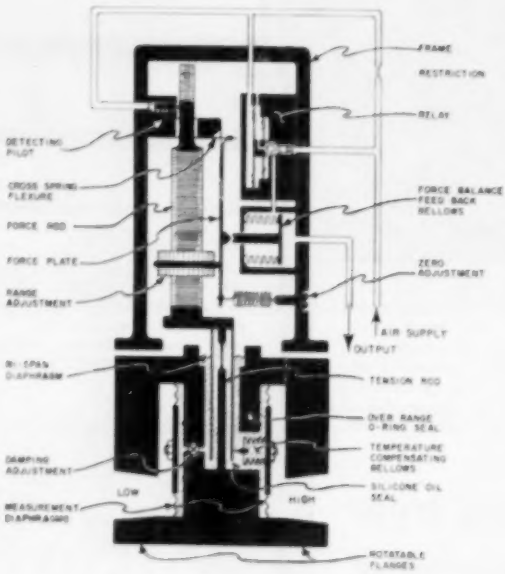
Aluminum Company of America
1000-L Alcoa Building
Pittsburgh 19, Pennsylvania

Please send me your new, FREE reprint, *Resistance of Aluminum Alloys to Weathering* and *Resistance of Aluminum Alloys to Chemically Contaminated Atmospheres*, and *Aluminum Pipe and Fittings*.

Name _____
Company _____
Address _____
City _____ Zone _____ State _____

Transmitter

. . . protects working parts from contact with process fluid. In this new differential pressure transmitter, fluid pressures are exerted on the outside surfaces of two diaphragms through a sealed-in oil chamber. The meter body and transmitter are separate, with all connections to the meter body to eliminate strain. Pressure rating is 1500 psig., temperature rating —20 to 300° F. The transmitter has a range of 0-20 to 0-200 in. of water. Fischer & Porter Co., Hatboro 35, Pa.



Circle No. **8** *on Reply Card*

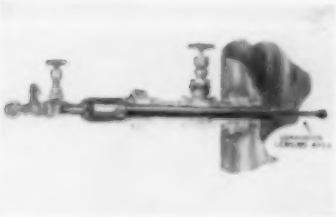
bar in relation to a nozzle. The resulting back pressure at the nozzle, amplified by an air relay, regulates a jet of air onto the blades of a turbine wheel. A weight, pivoted on the turbine wheel, produces a centrifugal force as it revolves. This force is fed back to the bar to balance the measurement signal. Totalization of the flow is recorded on a counter geared to the revolving turbine wheel. The device is weatherproof and dust-proof, and can be mounted on a panel or in the field. Replaceable gears are available for whatever unit of flow is desired. The Foxboro Co., Foxboro, Mass.

Circle No. **10** *on Reply Card*

Gamma Ray Projector

. . . that is portable can be used for radiography work. Designed in three sizes, 75 pounds, 250 pounds, and 2900 pounds (pictured above), the projector is extremely safe to operate, costs a fraction of comparable X-ray equipment, needs no electricity or control board, and can take pictures of 360 degrees. To be used primarily for checking welds in metal fabrication work, the new projector should be especially useful in field fabrication. The gamma rays escape from a radioisotope capsule mounted within the lead walls of the projector only when a lenseless shutter is opened. M. W. Kellogg Co.'s Nuclear Products Division is the manufacturer. Sales Agent is Metal & Thermit, New York, N. Y.

Circle No. **11** *on Reply Card*



Hydrogen Blistering

. . . can be detected by a device which gives a pressure warning that hydrogen blisters are corroding the walls of a metal tank. The "Texsteam Hydrogen Probe" is made of seamless steel tubing, one end of which is closed and machined to a thin-wall section. This sensing area is inserted into the chemical processing tank, and the other end is held in position on the outside of the tank. If the right combination of hydrogen-ions, sulfides, temperature and acidic compounds can penetrate steel and form hydrogen blisters, these blisters will be formed inside the thin wall section of the probe. Pressure from the hydrogen will create a reading on the probe's pressure gauge, thus warning of interior corrosion. The probe is designed so that it may be removed from pressure tanks during constant use, by the operation of the gate valve and packing arrangement. Probes are available in 18, 24, and 36 in. lengths equipped for flange, threaded or pressure lubricated mountings. Texsteam Corp., 320 Hughes St., Houston, Texas.

Circle No. **9** *on Reply Card*

Pneumatic Integrator

. . . Requires no cams for square root extraction, and provides continuous linear integration of industrial process flows to within ½% accuracy. The integrator receives a 3-15 psi. measurement signal from a differential pressure transmitter. Applied through a bellows, this signal positions a force

Hardfacing Paste

. . . can be applied without special skill, and imparts a deposit of high hardness and abrasion resistance. Available in tubes or jars, Hi-C 60

IN PETROLEUM *(Oil and Gasoline Additives)*

IN SURFACE COATINGS *(Paint, Varnish and Lacquer)*

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PETROLEUM	SURFACE COATING	CHEMICAL
PARANOX	PETRONOL 91	PETRONOL 91
PARATONE	PETRONOL 95	PETRONOL 95
PARAFLOW	PETRONOL 99	PETRONOL 99
PARAPOID	JAYSOL	JAYSOL
PARADYNE	Secondary Butyl Alcohol	Iso-Octyl Alcohol
PARATAC	Secondary Butyl Acetate	Decyl Alcohol
PETRONOL	Isopropyl Acetate	Denatured Ethyl Alcohol
Methyl Ethyl Ketone	Acetone	Tridecyl Alcohol
Dewaxing Aid	Methyl Ethyl Ketone	Dicyclopentadiene
Ethyl Ether	Dicyclopentadiene	Isoprene
Isopropyl Ether	Ethyl Ether	Butadiene
Reference Fuels	Isopropyl Ether	Ethyl Ether
	Naphthenic Acids	Isopropyl Ether
RUBBER	Iso-Octyl Alcohol	Tetrapropylene
ENJAY BUTYL	Decyl Alcohol	Tripropylene
VISTANEX	Denatured Ethyl Alcohol	Aromatic Tars
		Benzene
		Acetone
		Methyl Ethyl Ketone

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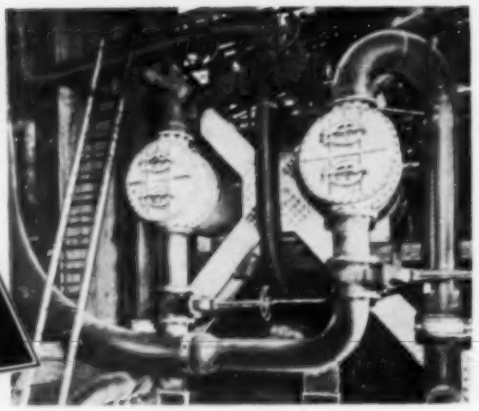
CONSECO EQUIPMENT

performs better
costs less to maintain

Conseco Condensate Coolers for hydrogen cooling installation in large utility. Note quick-opening doors for tube sheet inspection. Units are two-pass channel type. Courtesy Public Service Electric and Gas Co.



why?

Our Maintenance Division
has taught us the weak spots

. . . of practically all other makes of condensers, heat exchangers, pressure vessels, steam jet air ejectors, and other power and processing equipment. This experience in repairing, rebuilding, and modernization is applied by our manufacturing division in the design and production of Conseco Equipment.

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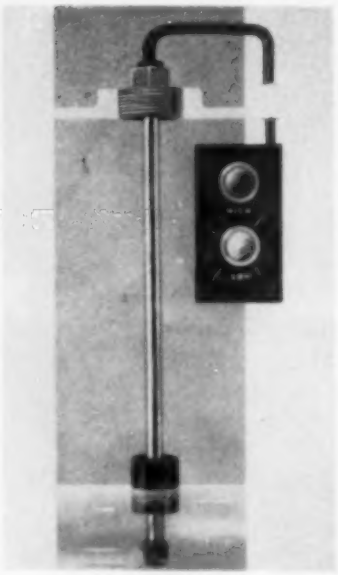
"Ruf-Nek" can be applied by brush or directly from the tube, and used on any metal with a melting point above 1850° F. Heat is applied with a gas flame or induction heating. The resulting surface has a hardness of 55 to 61, Rockwell C. Superweld Corp., 6840 Vineland Ave., No. Hollywood, Calif.

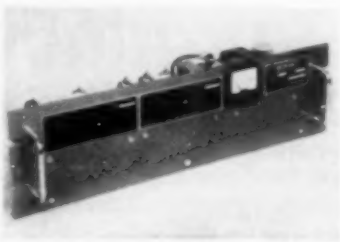
Circle No. **12** *on Reply Card*



Level Indicator

. . . operates warning lights or pumps through explosion proof switches. The movement of a foam plastic float on the indicator stem actuates the switches as it passes pre-selected points on the stem. The head assembly of the unit is a standard pipe plug, allowing installation on most tanks. Gems Co., 64 Welles Drive, Newington, Conn.

Circle No. **13** *on Reply Card*



Electronic Controller

. . . uses standard radio relay rack for mounting, and can be connected to other parts of "American-Microsen"

Fiberglas sets world's "elbow-bending" record!

THIS COMPLETE ELBOW COVERING FABRICATED IN ONLY 29 SECONDS!
Simple pie cuts with an ordinary knife produce perfectly fitting segments. No hacking . . . no sawing!

Yes, for speedy handling and fabrication on the job—not only elbows but straightaway runs and odd-shaped equipment, fittings and ducts—Fiberglas® Insulations recognize no equal! Such performance is possible because Fiberglas is light, rigid, non-crumbling, so easy to cut. What a time-and-labor saver! Moreover, it's moisture-resistant and dimensionally stable . . . combines sound absorption with thermal efficiency. Want to test its workability for yourself? Just write, Owens-Corning Fiberglas Corporation, Dept. 185-K, Toledo 1, Ohio.

Fiberglas PF Panels for equipment and ducts possess the same workability as the Pipe Covering illustrated at top of page.

For High Temperatures—KAYLO®, King of High Temperature Insulations. A faultless performer up to 1200° F. Distributed by Owens-Corning Fiberglas Corporation.

Technical data will be found in Sweet's File, Chemical Engineering Catalog and Refinery Catalog.

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Every RIDGID Pipe Tool
TESTED
individually before shipment
Extra Fast...
...easy...pipe reaming
with this self-feeding
RIDGID
Spiral . . . turns into the work smoothly, no chatter. Famous RIDGID heat-treated cutting edges mean clean reaming, extra long service. Quick enlarging of conduit box outlets—and holes in sheet metal. More for your money—buy the 2-S at your Supply House.
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and hand reaming . . .
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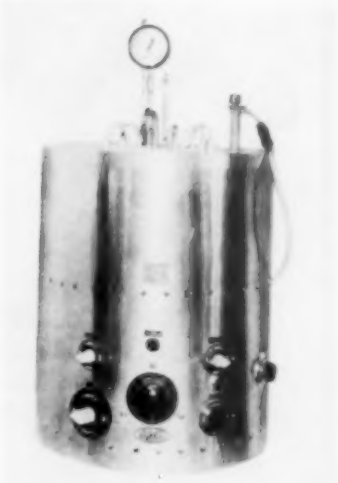
5 long straight flutes ream clean, easy to control.
RIDGID
Work-Saver Pipe Tools
The Ridge Tool Company • Elyria, Ohio • U.S.A.

electronic process control system with a prefabricated cable. It is not necessary to shield the controller from electrical interference when so mounted. Since there are no mechanical connections between the units, the instruments may be mounted close together in graphic or console type panels. Industrial Controls Division, Manning, Maxwell & Moore, Inc., Stratford, Conn.

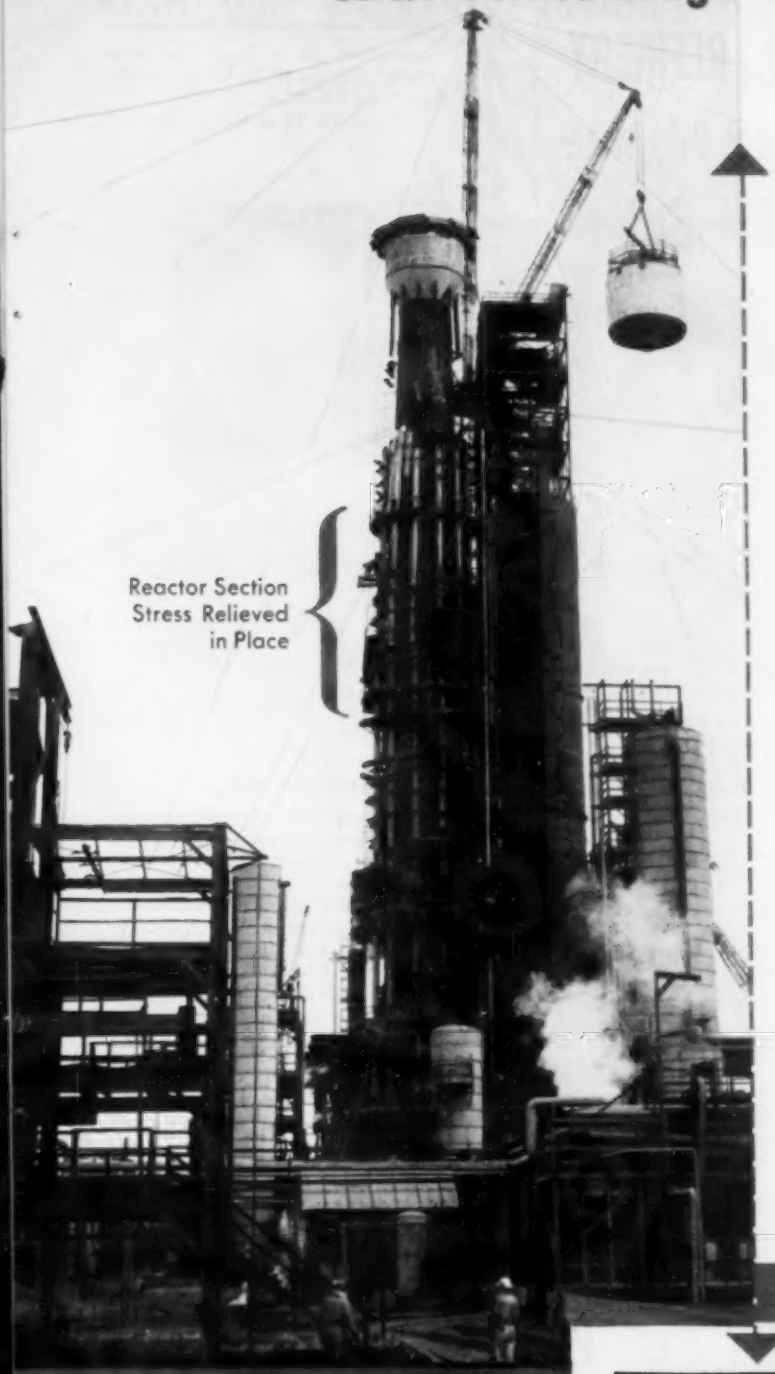
Circle No. **14** *on Reply Card*



Gum Determination Unit

. . . uses block of solid aluminum to improve the efficiency of its constant temperature bath. The coils for the vaporizing medium are completely imbedded in the aluminum. Proper manifolding permits equal distribution of air or steam to each jet outlet at the prescribed rate of flow of 1,000 ml./second. This unit for determining the existent gum in aviation and motor fuels is heated by high temperature sheath-type heaters, arranged to insure uniform heat distribution over the entire block of aluminum. The continuous heating system consists of one bank of heaters operating from a three-heat switch, and a variable heater controlled by an auto-transformer. The intermittent heater circuit also operates from a three-heat switch in conjunction with a sensitive thermo regulator and mercury type relay. Built into the low control compartment is an electric steam superheater which eliminates the need for an outside superheater installation. The standard apparatus is a 6 unit model, complete with breakers, thermometers, flow gauge, and superheater. Size is 18 in.

CB&I Solves tough erection problems on 360 ft. high Houdriflow Units at Toledo and Marcus Hook



360-ft. high Houdriflow unit at Marcus Hook during erection. It is one of two Houdriflow units fabricated at our Greenville and Birmingham plants through the Catalytic Construction Company for Sun Oil Company's Marcus Hook and Toledo Refineries.

Many problems confronted Chicago Bridge & Iron Company during the erection of two Houdriflow units that they fabricated and erected for the Sun Oil Company Toledo and Marcus Hook refineries. One was the lifting of 94-ton cooling coil sections 300 feet in the air. This was handled by derricks mounted on top of 283-ft. towers designed and built by CB&I especially for these jobs.

FIELD STRESS RELIEVING

Field stress relieving was an important problem that was successfully solved. Furnaces were built at Marcus Hook and Toledo to stress relieve 13 sections with internal and external heads, for each Houdriflow unit. The 70-ft. long reactor sections were stress relieved *in place* with 20-ton hot air furnaces mounted on the stair towers . . . *approximately 160-ft. in the air.*

FIELD X-RAYING

All the main seams in the reactor and regenerator, some of which were $2\frac{3}{8}$-in. thick, were 100 per cent X-rayed in the field.

When planning steel plate structures let CB&I experience and craftsmanship work for you. Write our nearest office for additional information.

CB&I

Chicago Bridge & Iron Company

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
Plants in BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.
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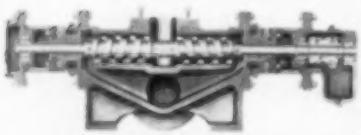
Esso BAYWAY (N.J.) REFINERY

pumps wide range of Fuel Oils with

Sier-Bath SCREW PUMP

The Sier-Bath Screw Pump above is handling fuel oils in viscosities from 60 SSU to 15,000 SSU, discharging against 200 psi., under operating temperatures of 100° to 200° F. Pump is an external gear and bracket type, having steam jacketed body.

Sier-Bath SCREW PUMPS



External Gear and Bearing Bracket Type for non-lubricating liquids and semi-liquids

Internal Gear and Bearing Type for lubricating liquids and semi-liquids

Sier-Bath Screw Pumps maintain high volumetric efficiency because "Dual-Controlled" precision rotor design prevents rotor-to-rotor or rotor-to-casing contact—provides a continuous flow without pulsation, hammering or vibration . . . without strains, misalignment and wear on rotors, shafts, bearings and gears.

Result: Dependable, uninterrupted pumping service—less downtime—less maintenance—easier servicing—longer pump life—lower overall pumping costs.

Capacities from 1 to 1,000 gpm.; viscosities from 32 SSU to 1,000,000 SSU; discharge to 1,000 psi. for viscous liquids, 200 psi. for water and light oils. Horizontal or vertical construction. Corrosion resistant alloys, special bodies, stuffing boxes and bearings for special needs. Call your Sier-Bath representative or write Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J

Sier-Bath ROTARY PUMPS

Screw Pumps Gerotor® Pumps Hydrox® Pumps

50th Anniversary Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings Member A.G.M.A.

diameter by 26 in. high. The Emil Greiner Co., 20-26 North Moore St., New York 13, N. Y.

Circle No. **15** *on Reply Card*

Receiver Recorder

. . . **will combine four records** from d-c pickups, a-c pickups, or pneumatic transmitters. The combined readings are recorded on the same uniformly-graduated, circular chart. Non-linearity that is inherent in many pickups is extracted by a characteristic cam in the receiver. Receiver ranges are 0-2 millivolts to 0-20 volts d-c. Error is less than ±¼% for spans of 10 millivolts or more, and ±25 microvolts for lower spans. Sensitivity is 0.05% for all spans. Pen speed is 5 seconds from 0 to 100% scale span. Power supply is 115 volts a-c, ±10 volts at 50 or 60 cps., 2 cps. Receiver will maintain rated performance at ambient temperatures between 40 and 120° F. Bailey Meter Co., 1050 Ivanhoe Road, Cleveland 10, Ohio.

Circle No. **16** *on Reply Card*

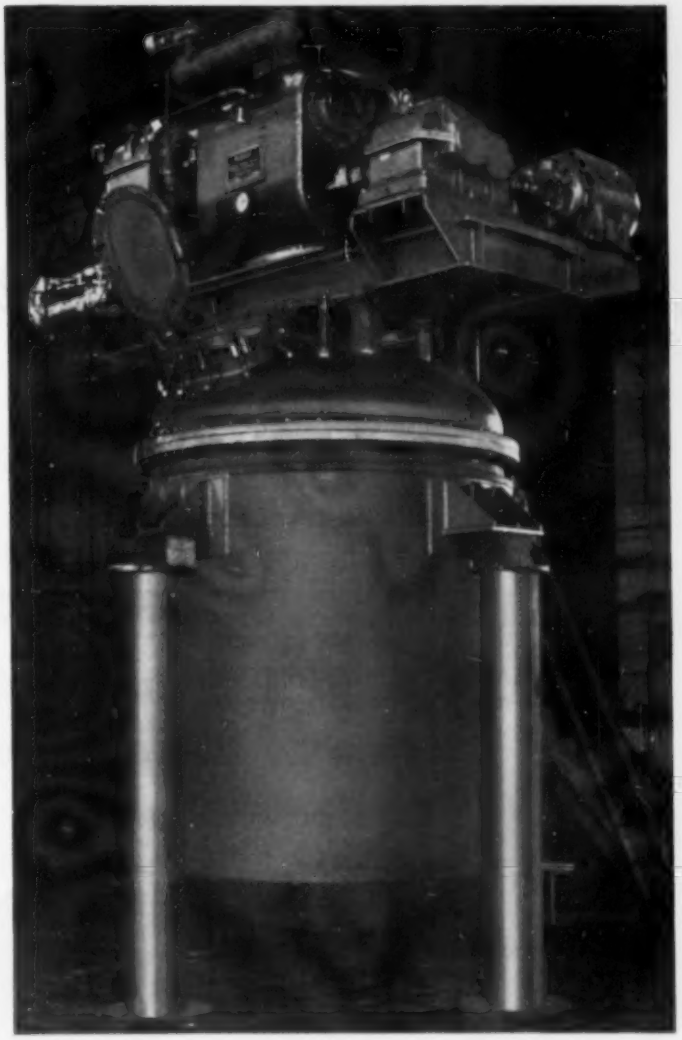
Tube Remover

. . . **handles 2 to 4-in. pipe** in difficult places without marring the outside surface. Designed to allow high wrench power in handling awkward sections of pipe, the Big Boy "Tube Tule" can be used on any type of pipe material; metal, fibre, glass, plastic or composition. The expansion of the six knurled segments against the internal surface of the pipe, creates a grasping force

Buflovak Jacketed Grease Kettles are engineered for specific process requirements

...to fit specific processing operation needs

...to provide profitable performance



The kettle illustrated is a Buflovak Jacketed Grease Kettle with a 2500-gal. capacity. It is equipped with a compact 150-hp Cone Gear Drive for operating a Double Motion Agitator, with scrapers, to speed operation. A pneumatic discharge valve saves valuable time. It was designed and engineered by Blaw-Knox engineers to meet the specific requirements of the operation for which it was built.

We can help you solve your kettle problems. Blaw-Knox engineers have had a broad experience in designing and building kettles of every description, from the laboratory few-gallon, capacity models to ones that process several thousand gallons not just greases but a large number of varied products. This experience enables our engineers to incorporate in the design of each kettle all the features that are particularly applicable to the operation under consideration. Such features include size of kettle, type of body, agitators, drive, high or low temperature control, method of heating and cooling, heat source, openings and outlets, and so on.

Why not call us and let Blaw-Knox engineers make their recommendations?

A Complete Process Equipment Service

Kettles of every description constitute but one phase of Blaw-Knox Process Equipment design, engineering and fabrication service for the chemical, food, pharmaceutical, plastic and resin, petroleum, rubber and other industries: EVAPORATION • DRYING • FLAKING • MIXING • REACTION IMPREGNATING • VULCANIZING • SOLVENT RECOVERY SOLVENT EXTRACTION • CRYSTALLIZATION • DISTILLATION POLYMERIZATION • GAS CLEANING • GAS ABSORPTION • HEAT TRANSFER • VAPORIZATION • CONDENSATION • STERILIZING LOW AND HIGH PRESSURE PROCESSING

CATALOG NO. 356-R is available on request

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BUFLOVAK EQUIPMENT DIVISION
1641 Fillmore Avenue, Buffalo 11, N. Y.

SEND FOR PSC

BUBBLE CAP BULLETIN 22

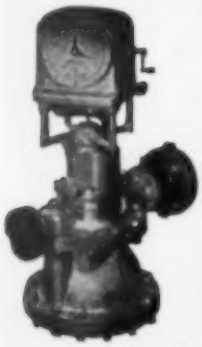
Largest Compilation of Engineering Data.

Lists 300 Styles Furnished Without Die Cost.

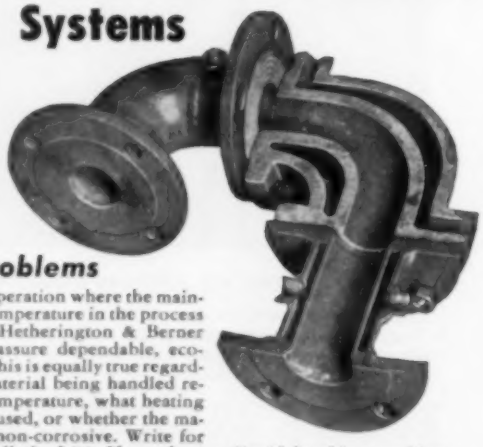
This standard reference on bubble caps and risers contains complete specification information for hundreds of variations. Also many drawings for use in determining methods of tray assembly. With dies on hand for all listed styles, PSC can save you substantial die costs as well as design and delivery time. Furnished in any drawing type of metal, to meet your coking or corrosion problems. Assemblies will also be produced to your specifications.

THE PRESSED STEEL CO., 717 N. Penna. Ave., Wilkes-Barre, Pa.

Custom Fabricators for the Process Industries Since 1928. Send Your Blue Prints.



COMPLETE Jacketed Pipe and Fluidometer Systems



for all liquid-handling problems

● In any processing operation where the maintenance of a uniform temperature in the process pipes is necessary, a Hetherington & Berner jacketed system will assure dependable, economical production. This is equally true regardless of whether the material being handled requires a hot or cold temperature, what heating or cooling medium is used, or whether the material is corrosive or non-corrosive. Write for Bulletin J-50. If you have a liquid batching problem, involving either light or heavy liquids, jacketed or unjacketed construction, investigate the *Fluidometer System.* This system gives accurate, dependable and *completely automatic* batching and is adaptable to practically any liquid measuring problem, whether it involves gallons, barrels or tank cars. Write for Bulletin FI-49.

H&B ESTABLISHED 1889

HETHERINGTON & BERNER INC.

731 KENTUCKY AVE. INDIANAPOLIS 7, IND.

that will not damage the tube. Double T Products Co., 301 Acacia St., Hawthorne, Calif.

Circle No. **17** *on Reply Card*

Teflon Tubing

. . . is available in all colors (or white) for identifying fluid streams. The sizes range from ⅛ in. to 1 in. I.D., and the wall thickness may be specified. Service temperature is from —300 F. to 500° F. Pennsylvania Fluoroplastics Co., 1115 North 38th St., Philadelphia 4, Pa.

Circle No. **18** *on Reply Card*

Free Trade Literature

Rubber Lined Valves

. . . for corrosive services: bulletin lists sizes, and dimensions for rubber lined gate valves and horizontal swing check valves, as well as metals and alloys for special service requirements. Darling Valve & Manufacturing Co., Williamsport, Pa.

Circle No. **19** *on Reply Card*

V-Belt Handbook

. . . allows quick and easy selection of constant speed "Texrope" drives. *"Tex-Book" 20P40* gives information on design features, basic drive principles and technical data on sheaves. Allis-Chalmers Manufacturing Co., 836 S. 70th St., Milwaukee, Wis.

Circle No. **20** *on Reply Card*

Lubricated Plug Valves

. . . dimensions, pictures and prices: 32-page *Catalog PV-4* lists steel and alloy valves and includes material specifications and recommended lubricants. The Wm. Powell Co., Cincinnati, Ohio.

Circle No. **21** *on Reply Card*

Plastic Pipe

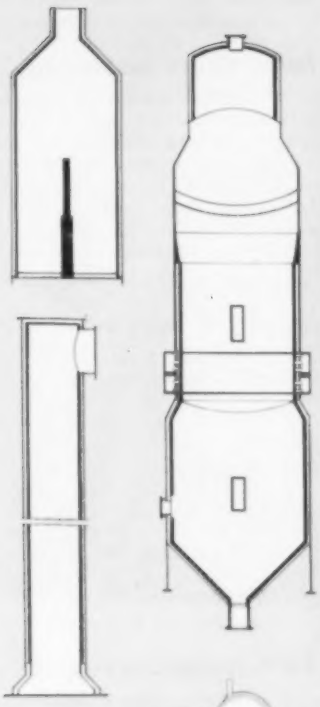
. . . uses in the oil industry: new catalogue inserts give specific technical information on "Kralastic" and "Tenite" plastic pipe with tables and graphs reporting chemical resistance and physical properties of both. Southwestern Plastic Pipe Co., P. O. Box 117, Mineral Wells, Tex.

Circle No. **22** *on Reply Card*

Expansion Joints

. . . and "Hydropads" for pressure surges: 34-page *Catalogue No. 52* tells how to determine amount of ex-

For Every Temperature and Operating Condition



Through the years Detrick engineers have been called upon to develop constructions that effectively meet every combination of conditions in heat enclosures.

In catalyst regenerators the abrasion must be considered together with low heat loss and gas tightness.

In boilers a heavier construction is necessary in the combustion area than in the upper areas. Detrick supplies the proper combination of design and materials to meet the conditions.

The contours and tube hangers in oil heaters present particular problems that have been handled by supported construction which takes the load off of refractories.

Sound engineering principles are demonstrated by the adaptability of Detrick constructions. For instance the Thermolayer construction is especially economical to apply to steel casings regardless of contour. It provides a refractory face backed by insulation and a poured layer which improves gas tightness.

If you have any problem involving heat enclosure get the benefit of Detrick's long engineering experience.

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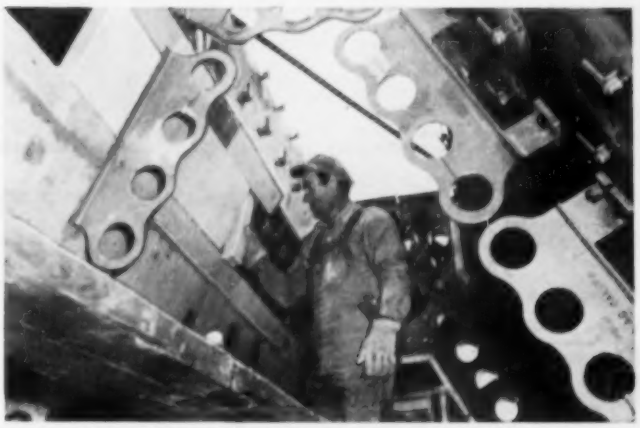
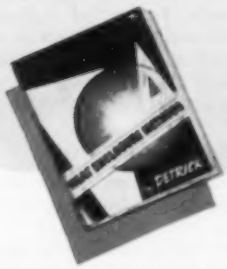
111 W. Washington Street • Chicago 2, Illinois



Thermolayer construction permits assembly in the shop. Complete unit can be shipped to operating location.



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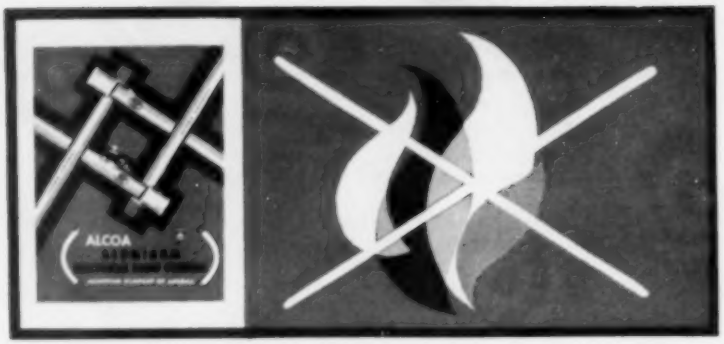

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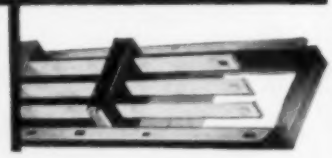

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pansion in a pipe line, and to compensate with "Magnilastic" expansion joints, as well as information on anchor joints, swing joints and turbo joints. Cook Electric Co., 2700 N. Southport Ave., Chicago 14, Ill.

Circle No. **23** *on Reply Card*

Foam Glass Insulation

. . . Properties, applications and available shapes: a new booklet contains recommended specifications for using this cellular glass insulation for piping and equipment. Temperature applications range from —500 to 800° F. Pittsburgh Corning Corp., One Gateway Center, Pittsburgh 22, Penn.

Circle No. **24** *on Reply Card*

Dutch Oil Equipment

. . . . for use in the oil industry: Netherlands Oil Equipment Manufacturers (N. O. E. M.) Catalogue, Edition 1955, lists equipment available from Dutch suppliers . . . from electronic control devices to pumps and tanks. Technical data for products are given in English. Copies may be obtained by writing direct to Secretariat, Netherlands Oil Equipment Manufacturers, 13, Nassaulan, The Hague, The Netherlands.

Do Not Use Reply Card

Air Pollution Surveys

. . . of refining units is described in new supplement issued by API. It provides data on the amounts of pollutants coming from refinery and nearby sources, the distribution of these materials in the surrounding area under varying meterological conditions, and the physical, chemical, and biological effects of various concentrations of polluting materials at specific points. *Supplement No. 2* to Vol. II on Waste Gases and Particulate Matter is available to all holders of the Fourth Edition of Volume II. Orders should be sent direct to American Petroleum Institute, 50 West 50th St., New York 20.

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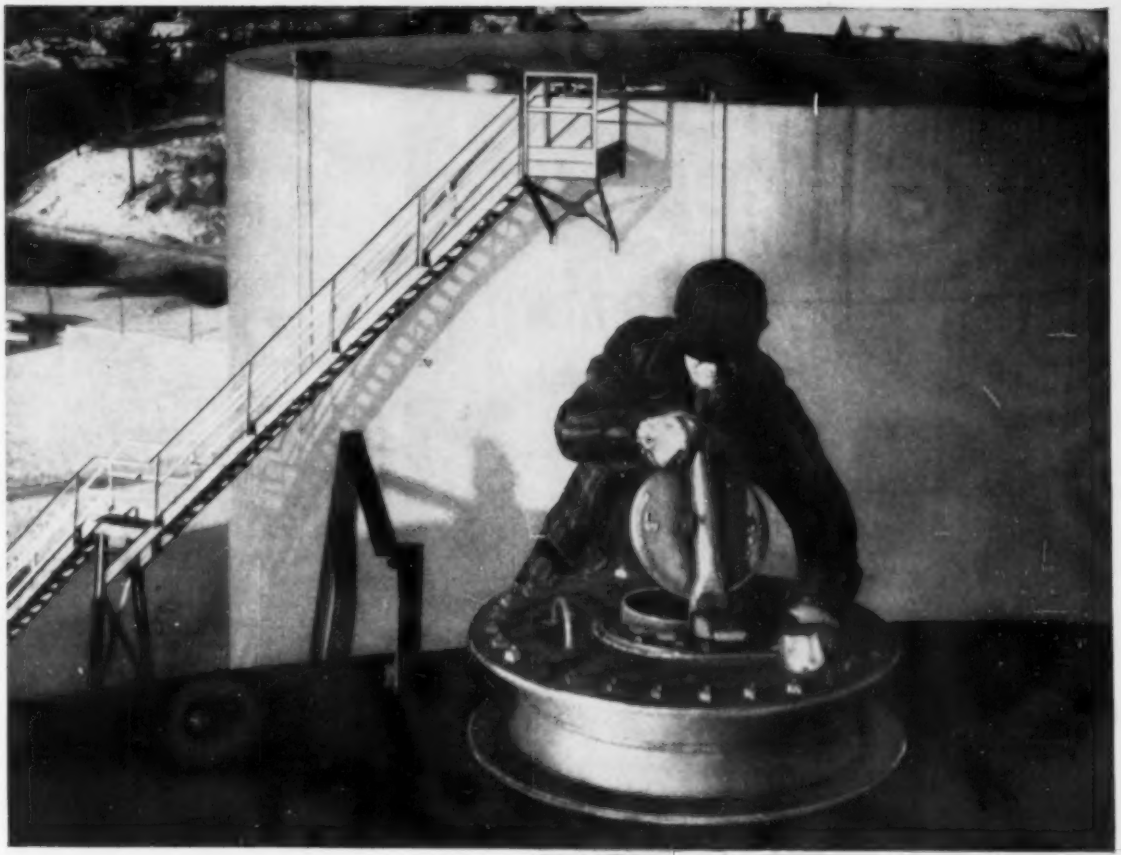
Junction Transistors

. . . their theory and application are described in new brochure. Both advantages and disadvantages of this amplifier device based upon the aplication of solid state physics to electronics are discussed. Motorola Inc.,

"Soyez les Bienvenus à Montréal au Mois de Mai!"



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Circle No. **25** *on Reply Card*

Catalysts of Molybdenum

. . . are described in a 24-page booklet. Reactions which may be catalyzed by molybdenum compounds, commercial processes now using these catalysts and factors to be considered in selecting one of these catalysts are discussed. Climax Molybdenum Co., Dept. L., 500 Fifth Ave., New York 36, N. Y.

Circle No. **26** *on Reply Card*

Rust Preventative

. . . **effectiveness,** as determined by radio active testing: 30-page Battelle Institute report describes tracing penetration of a fish-oil-based protective coating through rust to bare metal, after coating had been applied directly over rusted metal surfaces, through radioactive carbon. Make request on business letterhead direct to Rust-Oleum Corp., 2799 Oakton St., Evanston, Ill.

Natural Gasoline Plant

. . . its capacities, process flow, and components: 20-page brochure describes the design and construction of Signal Oil and Gas Co.'s new plant at Tioga, North Dakota. J. F. Pritchard & Co., 4625 Roanoke Parkway, Kansas City 12, Mo.

Circle No. **27** *on Reply Card*

Butterfly Valve Catalog

. . . in loose-leaf form can be kept up to date as new inserts are issued. Present edition contains 48 pages of basic engineering data allowing the user to size accurately any valve needed. Another 36-page addition is now being prepared. S. Morgan Smith Co., York, Pa.

Circle No. **28** *on Reply Card*

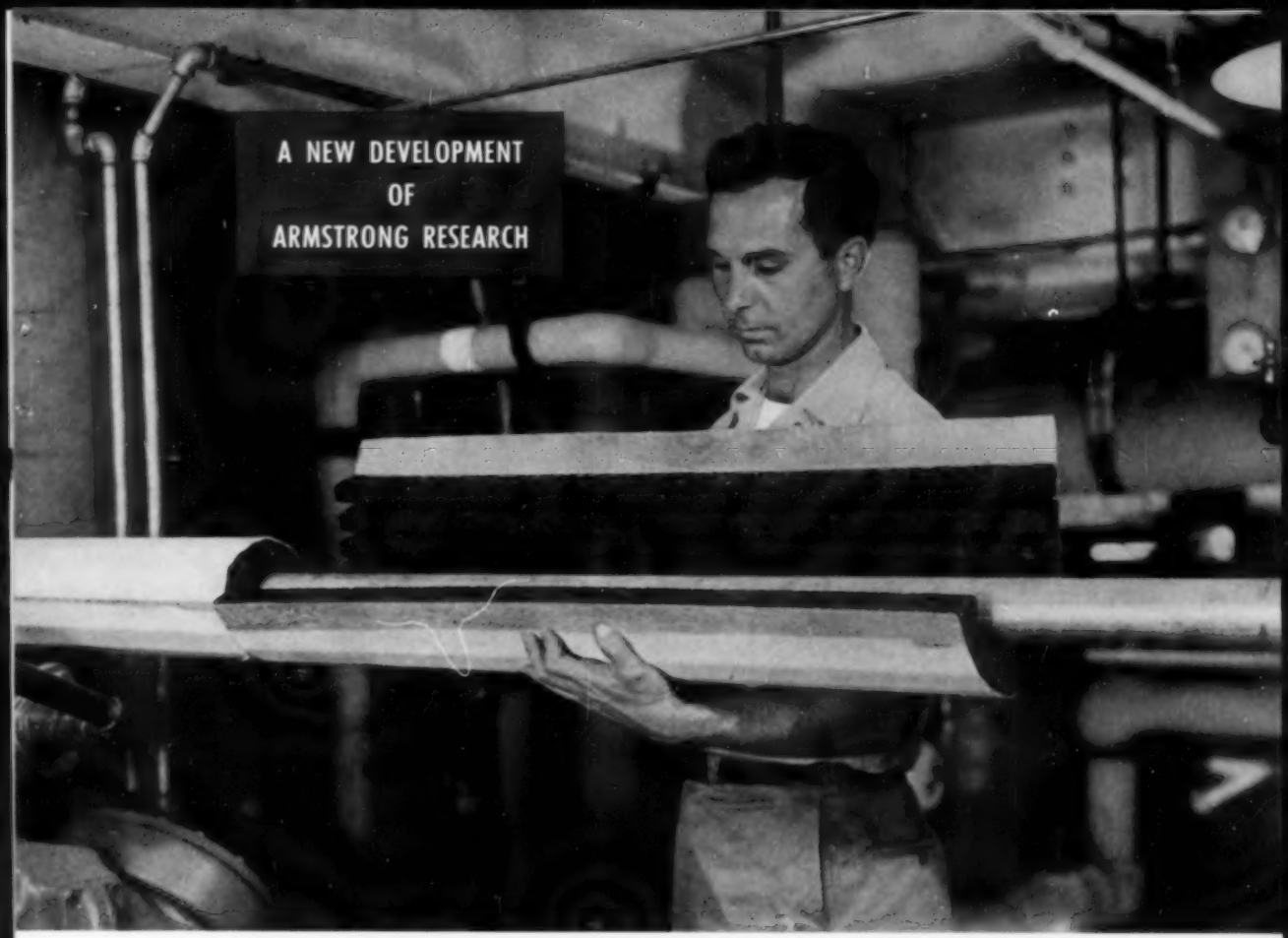
Silica Gel Dessicant

. . . for dehydration of air and gas: 15-page *Technical Bulletin No. 201* has charts, diagrams and tables describing advantages of using silica gel for natural gas installations. Davison Chemical Co., Div. of W. R. Grace & Co., Baltimore 3, Md.

Circle No. **29** *on Reply Card*

Boron Handbook

. . . on boron carbide and elemental boron gives technical information on



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This complete new line of economical cork pipe covering is designed to prevent condensation on lines operating at temperatures to 30° below zero. Available in three types—LT-Thirty, LT-Zero, and LT-Minus Thirty—these coverings offer the same high insulating efficiencies and long life as molded cork coverings, yet cost much less for materials and installation.

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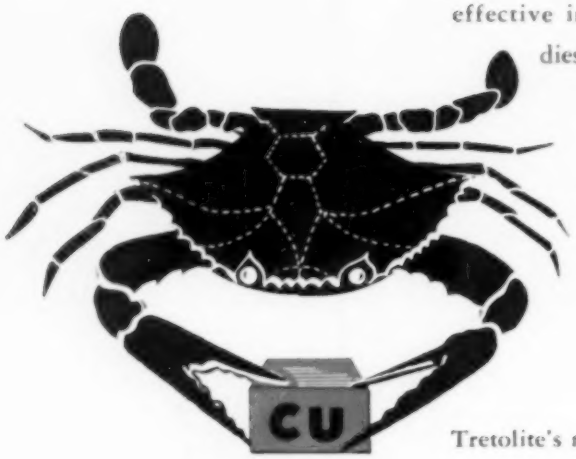

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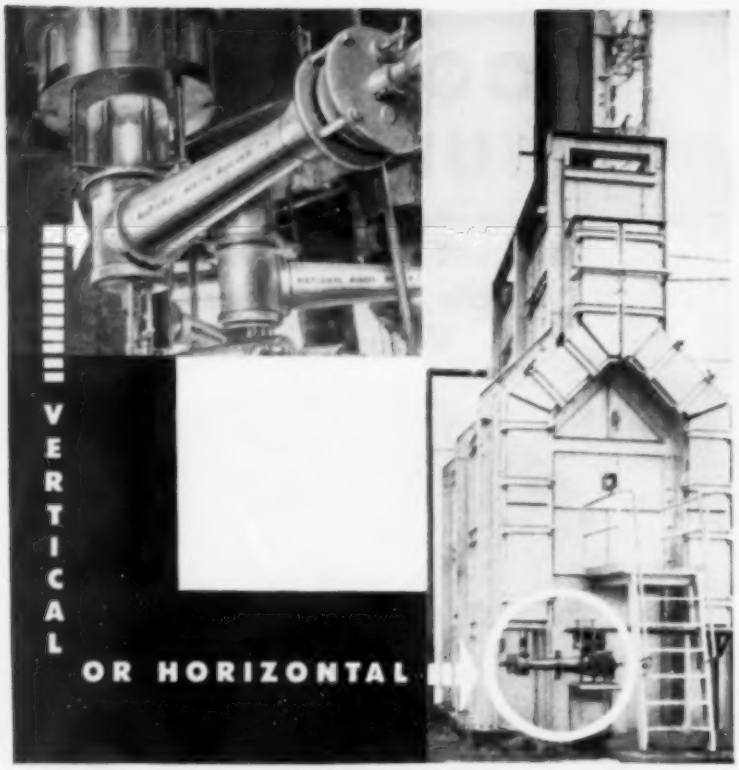

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materials for use in atomic energy. Includes the history of this element in the development of atomic energy, its compounds and a description of the activities of the Norton Co. in this field. Norton Co., Refractories Division, Atomic Products Section, Worcester 6, Mass.

Circle No. **30** *on Reply Card*

Bellows Relief Valves

. . . in sizes from 1½ to 6 in. inlet. *Catalog No. 300-JB* contains detailed information on pressure ratings of bellows, capacity data at various back pressures, and pressure-temperature limits. Cutaway drawing lists parts and materials used. Crosby Steam Gage & Valve Co., Wrentham, Mass.

Circle No. **31** *on Reply Card*

Pipe Fitting Developments

. . . for petroleum industry applications: 21-page *Bulletin 55-1* describes hot tap reinforcing tees, multiple outlet headers with seamless outlets, extra long radius elbows, pipe anchor flanges, and streamline design fittings for heater units including photographs, sketches and engineering drawings. Ladish Co., Dept. NR, Cudahy, Wisc.

Circle No. **32** *on Reply Card*

Graphite Pipe and Fittings

. . . are catalogued in new release. Couplings, ells, valves and plugs of Impervite, a resin-impregnated graphite, are described in this booklet. Also included is a how-to section on cutting threads, serrating and cementing this material in the field. *Catalogue No. 965.* Falls Industries Inc., Aurora Road, Solon, Ohio.

Circle No. **33** *on Reply Card*

Forged Steel Valves

. . . in globe and angletypes: *Bulletin 551* lists pressure-temperature ratings for 600 and 1500 lb. types and a description of design and construction details. Edward Valves, Inc., 1201 W. 145th St., East Chicago, Indiana.

Circle No. **34** *on Reply Card*

Low Cost Computer

. . . is available for small and medium size companies: a new brochure outlines the operation of "Readix" a medium speed electronic computer. Data output is reproduced as typed copy or on punched paper or magnetic

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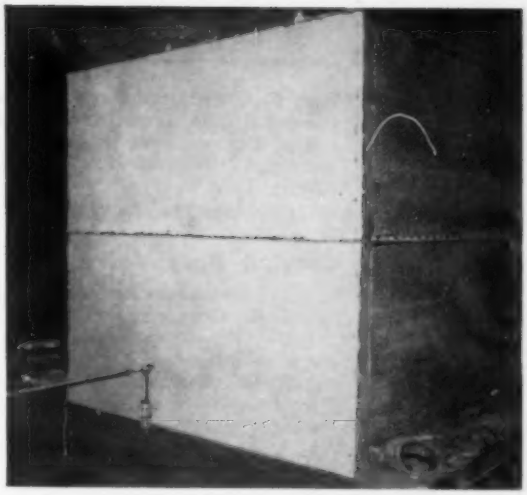

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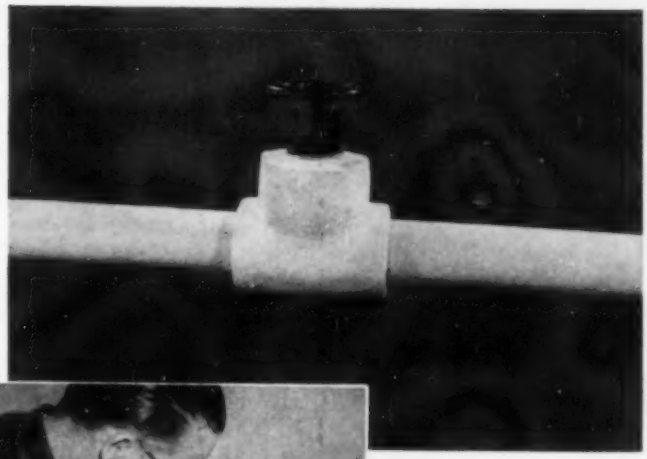

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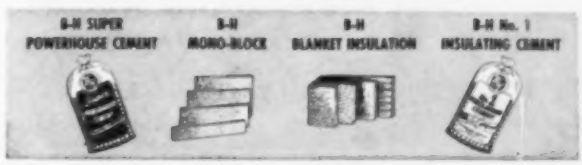

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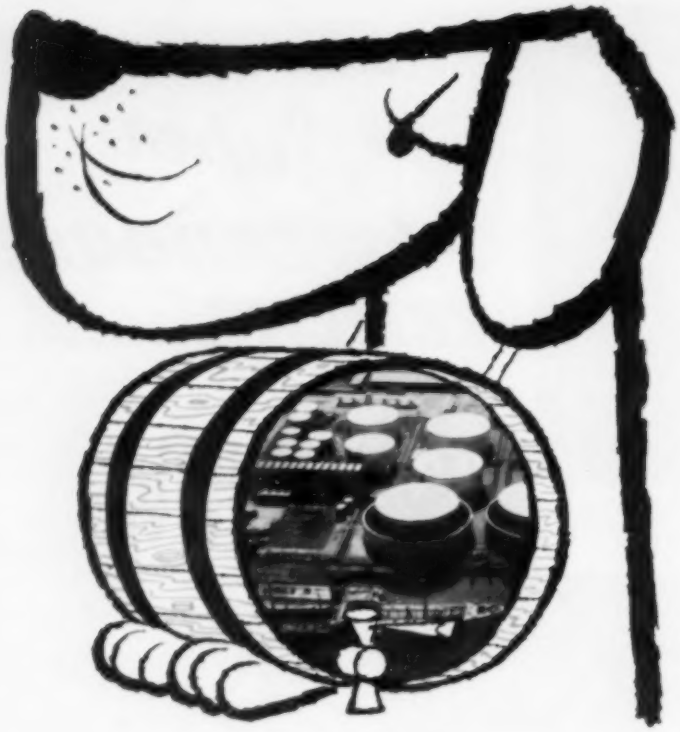

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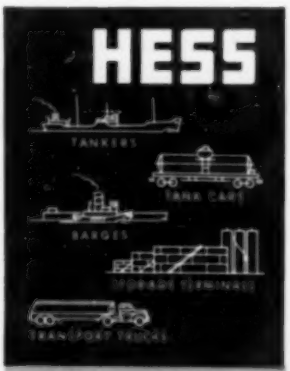

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tape. Computed results can also be transposed onto plotted charts at a rate of one point per second. J. B. Rea Co., 1723 Cloverfield Blvd., Santa Monica, Calif.

Circle No. **35** *on Reply Card*

Conduit Gate Valve

. . . has independent self-sealing system for either direction of flow: *Bulletin No. 5402* shows in color the operation of this special type of valve. Automatic self-sealing is attained through use of a sealing compound feeding system operated by line pressure. Darling Valve & Manufacturing Co., Williamsport, Penn.

Circle No. **36** *on Reply Card*

Pyrometer Maintenance

. . . for all users: *Bulletin F 7259*, an 11-page reference, covers service tips and techniques gathered from many applications of pyrometer controllers. Barber-Colman Co., Rockford, Illinois.

Circle No. **37** *on Reply Card*

Acrylic Esters

. . . their properties and reactions: *Bulletin F 7434* covers methods of polymerization, applications of polymers and copolymers, and selected references. Esters described are ethylacrylate, n-butyl acrylate, 2-ethylbutyl acrylate and 2-ethylhexyl acrylate. Carbide and Carbon Chemicals Co., 30 East 42nd St., New York 17, N. Y.

Circle No. **38** *on Reply Card*

Valve Catalogue

. . . supplement for Catalog F-9, covering Vogt general purpose valves. Special features, dimensions and material specifications for this line of valves are included. Henry Vogt Machine Co., Louisville 10, Ky.

Circle No. **39** *on Reply Card*

Boiler Tube Corrosion

. . . and eleven ways to avoid it; the subject of a recent folder by the metallurgical staff of Babcock & Wilcox. The result of an extensive study, the booklet explains in detail many causes of boiler tube corrosion. Tubular Products Division, Babcock & Wilcox, Beaver Falls, Penna.

Circle No. **40** *on Reply Card*

Heat-Transfer Fluids

. . . of polyalkylene-glycol derivation which differ in chemical nature and

high quality product

boost average ratings as much as 2 octane numbers with the

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With waste heat recovered and returned to the furnace in combustion air, the most modern heat-transfer systems can be operated at peak efficiency.

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In earnings from higher octane ratings, many refiners write off the cost of the Ljungstrom installation in less than two years. This time is cut to *nine months and even less*, when the other Ljungstrom advantages are taken into account — saves up to 20% in fuel costs . . . permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . and minimizes slag.

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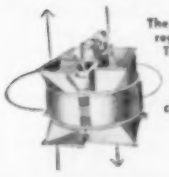

The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transfered from the waste gases to the incoming cold air.

The Air Preheater Corporation 60 East 42nd Street, New York 17, N. Y.

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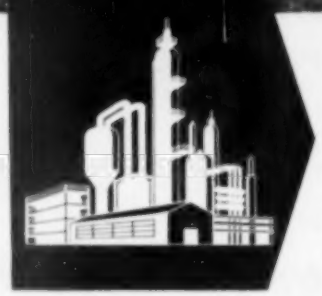

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"EFFICIENCY PROTECTION"

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E. Providence 14, R. I. Perth Amboy, N. J. Baltimore 3, Md. Mobile, Ala. Cincinnati 38, Ohio Columbus 15, Ohio Tucson, Ariz. Seattle, Wash. Baton Rouge 2, La. St. Louis 17, Mo. Inglewood, Calif. Oakland 1, Calif. Portland 7, Ore. Washington 5, D. C. San Juan 23, P. R.

performance from natural oils and other synthetic heat-transfer fluids. A new technical data folder, *Form 7490*, describes how to use "Ucon" fluids, their advantages, and properties. Carbide and Chemicals Co., Div. of Union Carbide and Carbon Corp., 30 East 42nd St., New York 17.

Circle No. **41** *on Reply Card*

Boiler Tube Corrosion

. . . and eleven ways to avoid it: the subject of a recent folder by the metallurgical staff of Babcock & Wilcox. The result of an extensive study, the booklet explains in detail many of the causes of such corrosion. Tubular Products Division, Babcock & Wilcox, Beaver Falls, Penna.

Circle No. **42** *on Reply Card*

Tube Fitting Data

. . . in form of load variation charts show yield of type 304 stainless steel tubing, when held by "Swagelok" tube fittings. The data are for ½, ¾, and 1 in. stainless tubing of various wall thicknesses, and in pressures at temperatures ranging from 70 to 1800° F. Also shown are allowable loads calculated from "S" values as specified by ASTM. Crawford Fitting Co., Cleveland 10, Ohio.

Circle No. **43** *on Reply Card*

Suntide Refinery

. . . at Corpus Christi, Texas: the subject of a brochure issued by the Lummus Co., designer and constructor of this recent project. The 15-page booklet describes each of the main operating units, and auxiliary sections, with supplementary photographs. The Lummus Co., 385 Madison Ave., New York 17, N. Y.

Circle No. **44** *on Reply Card*

X-Ray Training Films

. . . for those in diffraction and spectrography work. "The Ultimate Structure" is a 40-minute, black and white sound film available to schools or industrial plants. It may be booked on a loan basis, or may be purchased at cost. Wave motions and crystal theories are demonstrated. Typical examples of research and production control applications are included. Research & Control Instruments Division, North American Philips Co., Inc., 750 South Fulton Ave., Mount Vernon, N. Y.

Circle No. **45** *on Reply Card*

"Soyez les Bienvenus à Montréal au Mois de Mai!"

for aldehyde distillation
Stainless Steel

The towers, internals and piping of this distillation unit for aldehydes, in service at a petrochemical plant in the Southwest, take advantage of the corrosion resistance of Stainless Steel.

This growing industry is solving many of its problems of heat and corrosion with Stainless Steel. And in USS Stainless Steel you have a wide variety of compositions to meet almost any problem. Our booklet, "Performance of Stainless Steel in Petroleum Refinery Service," describes how USS Stainless Steel has met problems similar to those you are encountering. For your copy, write to United States Steel Corporation, Room 5002, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL CORPORATION, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO • NATIONAL TUBE DIVISION, PITTSBURGH
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

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UNITED STATES STEEL

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Auto-Lite Temperature Indicators are ideal for use in processing and storage rooms, and for installation on equipment where temperature indication is desirable.

Model F-1 (illustrated) is available with maximum visibility dial; choice of temperature ranges from minus 60°F to plus 750°F; flexible tubing for remote reading or rigid stem for direct mounting. Adjustable electrical alarm contacts slightly higher. Priced from $22.

Send for new catalog describing Auto-Lite Temperature Indicators and Recorders.

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INSTRUMENT AND GAUGE DIVISION
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HIGH QUALITY
ANHYDROUS
Aluminum Chloride
PRODUCED IN TWO GRADES
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THE PUREST COMMERCIAL MATERIAL AVAILABLE

ANY PARTICLE SIZE OBTAINABLE
OUR STANDARD SIZES
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INFORMATION CONCERNING THE PREPARATION of AQUEOUS OR ALCOHOLIC SOLUTIONS OF $AlCl_3$ OBTAINABLE BY WRITING

OHIO-APEX DIVISION
FOOD MACHINERY & CHEMICAL CORPORATION — NITRO, W. VA.

OHIO APEX fmc

fmc FOOD MACHINERY AND CHEMICAL CORPORATION

Silicone Rubber Insulation

. . . for motor and generator stator windings: the subject of a new leaflet explaining the superior electrical, thermal and mechanical properties claimed for this insulating system. Graphically presented are data for dielectric strength, accelerated aging, power factor comparisons with other types of insulation, and elongation and tensile strength properties. Allis-Chalmers Mfg. Co., 836 S. 70th St., Milwaukee, Wis.

Circle No. **46** *on Reply Card*

Air Blower

. . . for gas or vapor under pressure or vacuum: *Folder B-154* gives engineering details and technical specifications of the "Standardaire." This is an axial flow, positive-displacement blower that takes in and discharges air by the intermeshing of two mating rotors. Operating with a few thousandths inch clearance, the rotors need no lubrication and deliver air at discharge pressures ranging from vacuum to 18 psig. Capacities range from 100 cfm. to 3500 cfm. Read Standard Corp., 370 Lexington Ave., New York 17, N. Y.

Circle No. **47** *on Reply Card*

Hydraulic Tables

. . . and other engineering data: 28-page reference book for those interested in pumping and piping problems. A new edition of this handbook. Aldrich Pump Co., 25 Pine St., Allentown, Penna.

Circle No. **48** *on Reply Card*

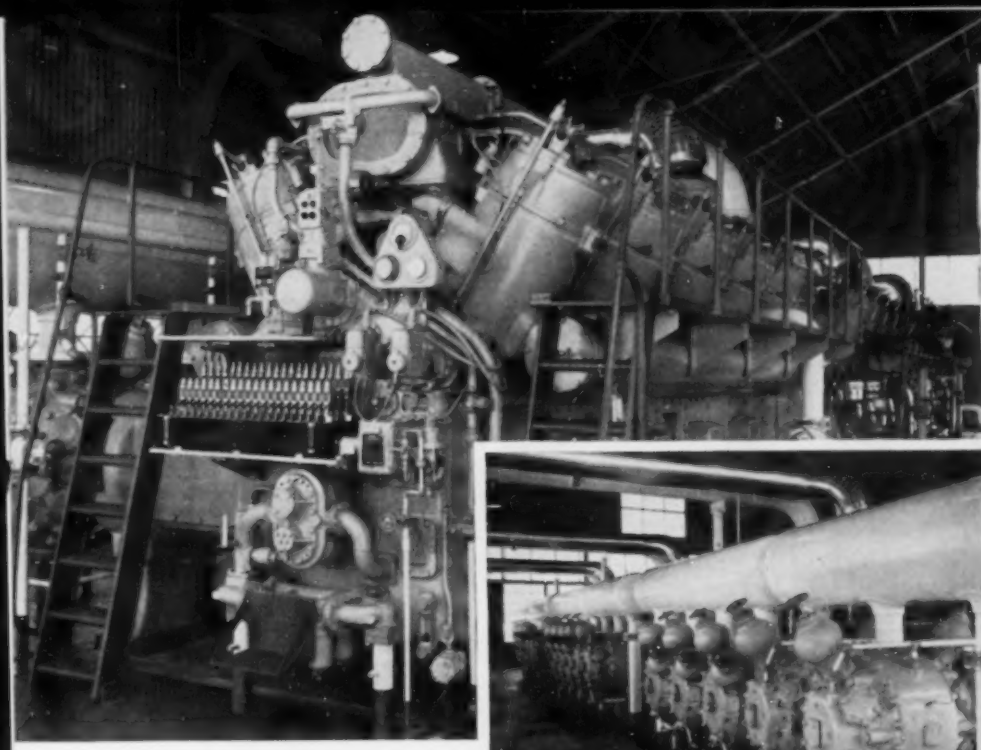
Did You Miss These?

The following items, reviewed originally in August, have aroused considerable interest among the readers. They are repeated briefly as a service to those who might have missed them the first time they appeared. For details or literature, please use the regular Reply Card in this issue.

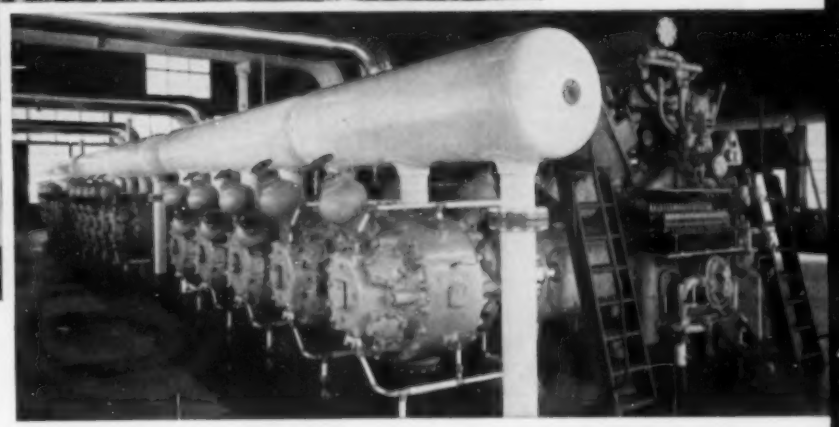
Plastic Blanket

. . . cuts evaporation losses from tanks storing volatile liquids. A blanket made of polyvinyl chloride and re-

FROM YOUR BASIC FLOW DIAGRAMS



Another Example of Efficient Power at Lower Cost



Shown here are different views of the 10-cylinder Cooper-Bessemer GMVA compressors in the Pembrook Station of the El Paso Natural Gas Company. These five GMVA's, each rated 1350 hp at 300 rpm, are used in field boosting of natural gas.

10 MONEY-SAVING FACTS YOU SHOULD KNOW ABOUT NEW COOPER-BESSEMER GMVA COMPRESSORS

The new GMVA produces 35% more power than the original GMV; 23% more than the Turboflow type.

This power gain is accompanied by a full 25% reduction in fuel consumption over the original engine and 10% over that of the Turboflow type.

Improved fuel utilization means less heat is lost to jacket water and lube oil — more work!

Therefore the gain in power is obtained with no increase in exhaust temperature.

The improved power-to-temperature ratio reduces the demand for heat dissipation to water, permitting smaller auxiliary equipment.

Built-in centrifugal blowers, of Cooper-Bessemer design, provide greater scavenging air volume at low pressure for smooth, efficient performance at all loads and conditions.

With fewer parts, and components of improved design, the GMVA offers unmatched reliability, with minimum maintenance and part replacement.

Full-flow lube oil filtration assures complete protection against foreign particles and neutralizes acidity.

Improved design provides ample working space around power cylinders for simplified inspection and maintenance.

In short, minimum space per installed horsepower, with over-all economy and unexcelled performance.

MOUNT VERNON, OHIO

COOPER-BESSEMER

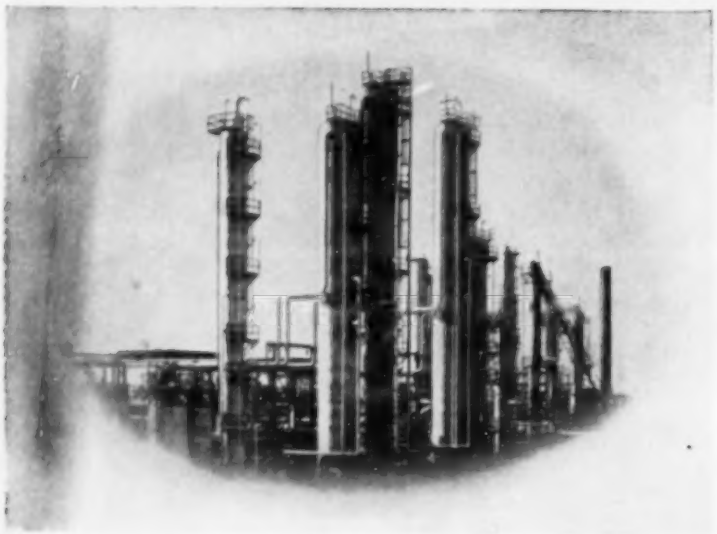
GROVE CITY, PENNA.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. Houston, Dallas, Greggton, Pampa and Odessa, Texas Washington, D. C. • Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. • Gloucester, Mass. • New Orleans, La. • Tulsa, Okla. • Cooper-Bessemer of Canada Ltd., Edmonton, Alberta—Halifax, Nova Scotia.

Check all the cost-cutting factors . . . efficiency, service life, maintenance, installation cost, supervision, etc. . . . you'll find Cooper-Bessemer V-angles are your best bet for *better* compressor service. Write today to The Cooper-Bessemer Corporation, Mount Vernon, Ohio, for your copy of the new and complete GMVA Bulletin 75.

DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS

FROM YOUR BASIC FLOW DIAGRAMS— A FINISHED PLANT QUICKLY, ECONOMICALLY



A plant designed for *your* needs based on *your* process flow diagrams—this is the service we offer petroleum refiners. Each Kuljian project is unique because it is designed . . . and built . . . with just one objective in mind—the maximum return on your investment at the earliest possible date.

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ENGINEERING AND CONSTRUCTION

Kuljian Experience Includes:

Refinery Facilities In General
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Steam Generation & Utilization
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The Kuljian Corporation
engineers • constructors
1200 North Broad Street • Philadelphia 21, Penna.

BRANCH OFFICES THROUGHOUT THE WORLD

cently introduced into this country by Societe LaRoche Freres, a French company in Paris, is effective for crude petroleum, gasoline, alcohol, etc., tankage. Evaporation during test runs did not exceed 10-20% of the losses experienced in tanks without the blanket. Blanket construction consists of a continuous, flexible carpet covering the free liquid surface up to within one inch of the tank wall, and a "Z"-shaped skirt around the edge of the carpet to form a vapor seal against the side of the tank. The bottom of the carpet is provided with a large number of small parallelepipedic floats arranged side by side. Openings, fitted with vertical sleeves, are provided in the blanket to allow measuring and sampling, and to allow the level indicator float to pass through. Small holes are provided every square yard to allow evacuation of condensation water. Plastic tubes (PVC) attached below the blanket prevent its dropping lower than the tank filling openings when the tank is empty. The floating blanket is carried in sections cylindrically rolled, which allows convenient insertion of it through a tank manhole. Electrostatic charges, which are built up in the tank during filling, are eliminated by means of a continuous wire netting on the blanket. This grounded netting traps all electrostatic charges on the surface of the liquid, providing a protection not found in tanks without such a blanket. The U. S. manufacturer of the floating plastic blanket is W. K. Archer Co., 75th and Cleveland Ave., Kansas City, Mo.

Circle No. **49** *on Reply Card*

Computer Reads Pulsations

. . . in flow rates and volumes by using pressures—static and differential—to give direct readings. In essence, a computer has been inserted in the pressure measurement train between the orifice and the recorder, or recorder-controller. In addition, an integrator can be used to give total volume over a period of time, and the computer output may be used for pulse telemetering to remote locations. The device uses the conventional hook-up on the orifice of a D-P cell to furnish impulses to the computer. Advantages include instantaneous readings as compared to manual data reduction of a regular recorder flow chart, and an accuracy of ±1% of maximum rated capacity over the operating range. The computer determines the true average value of pulsating flows at frequencies up to 500 pulsations/minute, and integrates over

Will this blot spread... or shrink?

NOTHING STRIKES so brutally at human lives as a slum.

Yet of America's many millions of homes, the blot that is a slum covers more than 1 out of every 10 . . . and nearly one-half of all our homes are urgently in need of repair and basic improvements.

Will the blot go on spreading? Or will a concerted, nationwide attack on the causes of slums shrink it, year by year, until it is wiped out? Today, this is a challenge to every American . . . a challenge that *must* be met.

Your community . . . your problem!

A slum reaches across blocks, across miles, to sit on your doorstep and demand a price.

You pay it in the threat of crime and juvenile delinquency to your family. You pay the price in higher personal property taxes to fight the disease and crime and poverty that are slum-bred. You pay personally when the value of your home sinks as community deterioration takes another step closer.

Your *firm* pays when the community where you do business goes downhill. Slums automatically mean lower purchasing power and less effective labor.

Good citizenship is good business

It's good citizenship and good business both for your firm to join efforts to check housing decay . . . to stop slums before they start. In fact, it's the *responsibility* of every business, as it is of every other good citizen, to support community improvement efforts.

Some slums are beyond repair. They should be torn down and a fresh start made. Others can be remodeled, made to conform to better living standards. So it is up to you to get behind every sound program which seeks to provide adequate housing for all our people.

Adding your support to the efforts of the millions already attacking the problem, your firm can help stop slums cold and put America's housing standards at a new height.

How to get into action

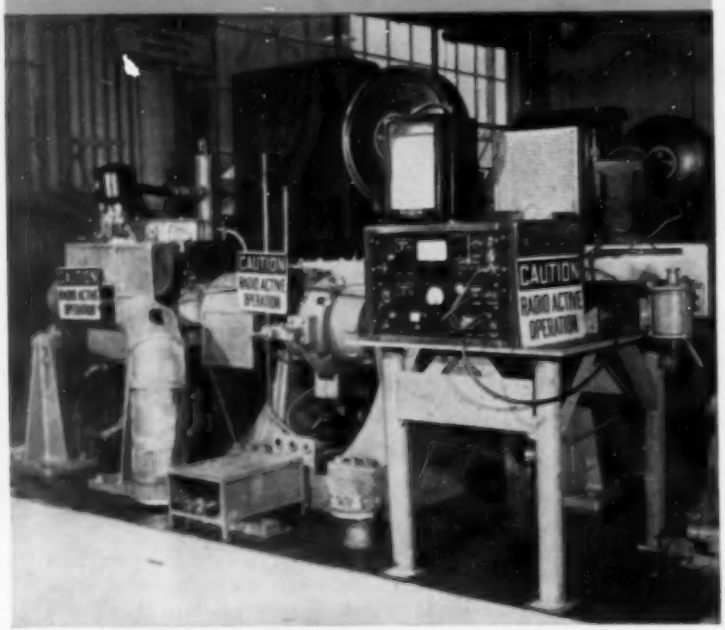
A group of Americans from every walk of life has formed a new, non-profit organization to help combat home and community deterioration — The American Council To Improve Our Neighborhoods . . . A.C.T.I.O.N.

Send for a free copy of "ACTION." It explains what A.C.T.I.O.N. is and proposes to do. It also lists booklets, research reports, check-lists, and other material which can help you protect the housing health of your community. Address P. O. Box 500, Radio City Station, New York 20, N. Y.

ACTION

American **C**ouncil **T**o **I**mprove **O**ur **N**eighborhoods

Better oil performance at a competitive treating cost with Oronite Lube Oil Additives



Using the latest research techniques and test methods, such as determination of engine wear by use of radio-active tracers, (shown above), Oronite has developed a complete line of lubricating oil additives for all types of oil service.

Throughout the nation, marketers of Oronite additive compounded motor oils are gaining better sales positions with superior finished products they market. Better performance from Oronite additive compounded oils is due in part to Oronite's "custom-formulating" program of providing additives that meet the specifications of the individual oil marketer. And because of Oronite's years-ahead research, testing and manufacturing facilities, custom-compounding has been accomplished at progressively lower treating costs.

Why not talk over your problem with an Oronite additive specialist. Contact the Oronite office nearest you.

With Oronite Additives you can formulate oils to meet the new A.P.I. Service Classifications and can meet specifications for MIL-L-2104A, MIL-L-9000, Supplement I and Series 2 oils.

PARTIAL LIST OF OTHER ORONITE PRODUCTS
Gas Odorants
Polybutenes
Phenol
Wetting Agents
Fuel Oil Additives

ORONITE CHEMICAL COMPANY
200 Bush Street, San Francisco 20, California
30 Rockefeller Plaza, New York 20, New York
20 North Wacker Drive, Chicago 6, Illinois
714 W. Olympic Blvd., Los Angeles 15, California
Mercantile Securities Building, Dallas 1, Texas
Carew Tower, Cincinnati 2, Ohio

ORONITE CHEMICAL COMPANY

each cycle. The output of the computer may be read directly or recorded. On special orders the integrated volume readings—displayed digitally—may be read out on printed tape or punched cards. Contacts for pulse telemetering may also be provided, and the computer output may be used for automatic control of compressor speed or valve setting. Southwestern Industrial Electronics Co., Industrial Instruments Div., P. O. Box 13058, Houston, Texas.

Circle No. **50** *on Reply Card*

Water Pollution Abatement

. . . in oil and tar discharges: *Manual Sheet W-4*, part of a series on water pollution, covers permissible concentrations and removal techniques, and has diagrams of API separator, air induced flotation method, and hay filter installation. Manufacturing Chemists' Association, 1625 Eye St., N. W., Washington 6, D. C.

Circle No. **51** *on Reply Card*

Control Valve Sizing

. . . manual for steam, liquid, and gas services: 24-page *Controls Sizing Manual* includes graphs and tables of steam enthalpy-volume, flow rates, valve coefficients, and molecular weights as related to type of valve. Black, Sivalls & Bryson, Inc., 7500 E. 12th St., Kansas City 26, Mo.

Circle No. **52** *on Reply Card*

Protective Coatings

. . . compared as to properties: *"Comparative Properties of Protective Coatings,"* a 19-page report by Gerald F. Gilbert, Jr., to the National Association of Corrosion Engineers, treats 14 types of coatings, giving physical and chemical data, value of the coatings against weather, impact, abrasion, heat, water, and various kinds of chemical attack. Atlas Mineral Products Co., Mertztown, Pa.

Circle No. **53** *on Reply Card*

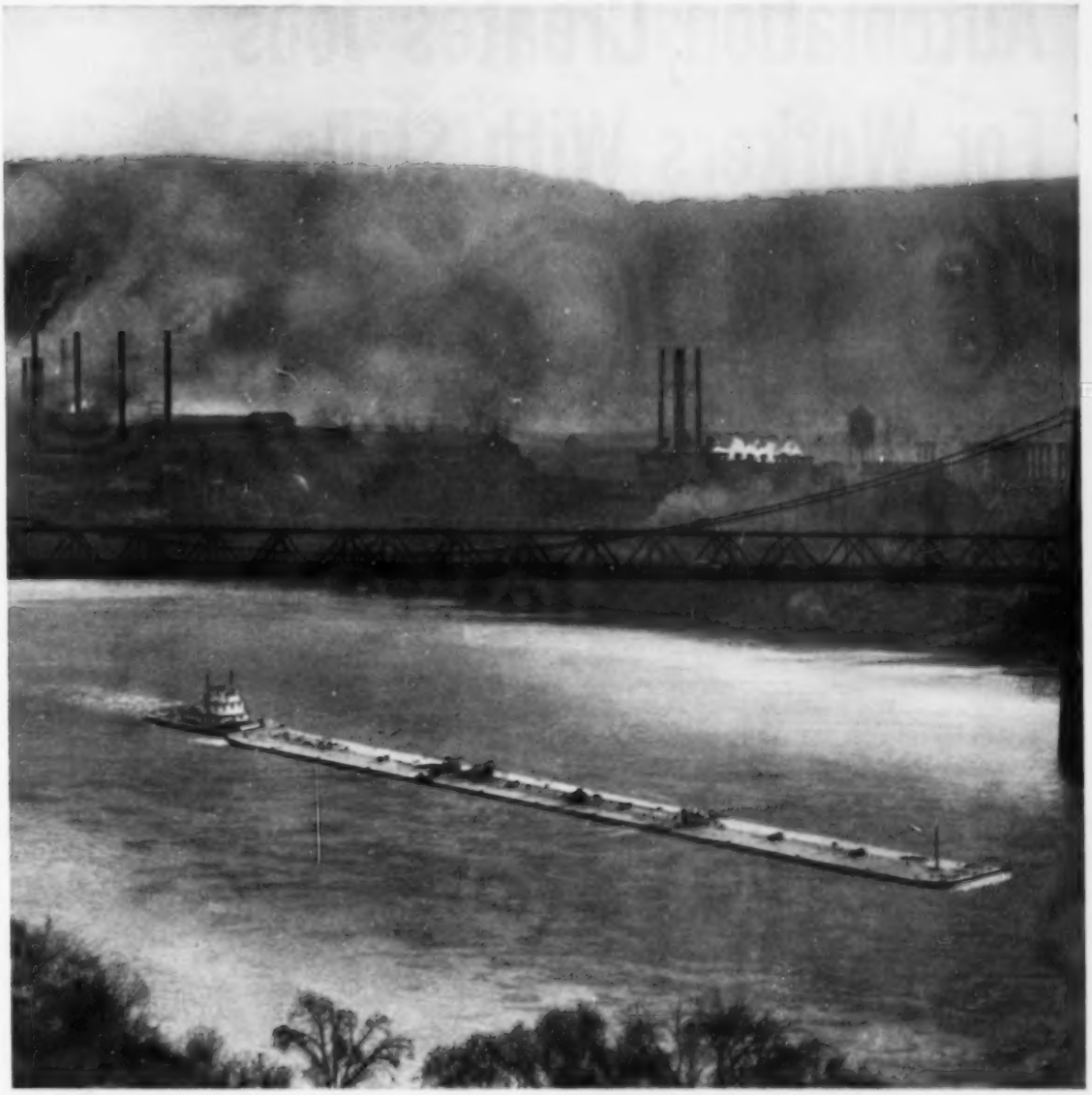
All About Amines

. . . including older and newer reactions, physical and chemical properties, and a long list of applications from the company's experience and the literature: 52-page *"Sharples Amines."* Sharples Chemical Division, Pennsylvania Salt Mfg. Co., 3 Penn Center Plaza, Philadelphia 2, Pa.

Circle No. **54** *on Reply Card*

"Soyez les Bienvenus à Montréal au Mois de Mai!"

GOING PLACES *on the nation's rivers with Cities Service...*



Cities Service petroleum products travel by fast supertankers... they also move by plodding barge over the nation's inland waterways from Cities Service refineries to major midwest distribution centers... today they are traveling over water, over land and underground in record quantity, to meet a record customer demand.

CITIES SERVICE

A Growth Company

Number 14 of a series

Automation Creates Jobs For Workers With Skills

There is new and reassuring information for those who fear that "automation" – the control of machines by machines – will mean fewer job opportunities. It comes from a special survey of 1,574 companies in metalworking industries recently completed by AMERICAN MACHINIST, a McGraw-Hill publication. More than one-fifth of the companies reported that they already have automatic loading, transfer or assembly machinery in operation. In these companies as a whole there has been a net increase in total employment since this machinery was installed.

According to the AMERICAN MACHINIST survey, of these companies with actual experience in automation

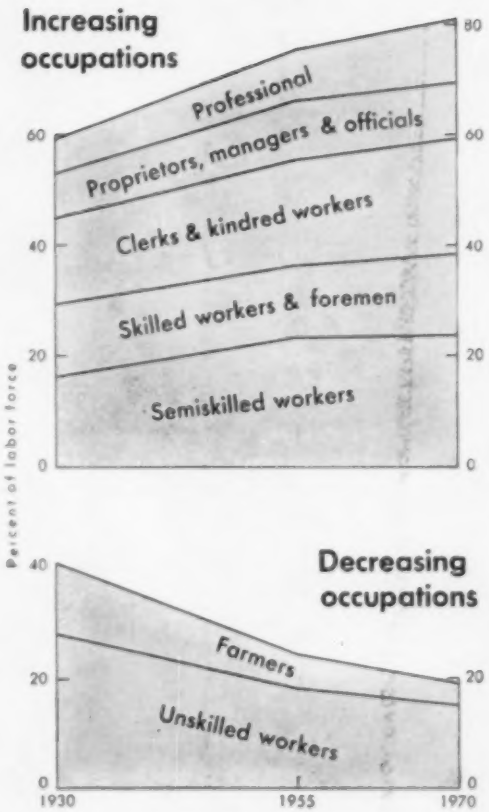
- 26% reported increases in employment averaging 21%
- 51% reported no change in total employment
- 23% reported decreases in employment averaging 16%

More Jobs for the Skilled

Of greater significance, however, is the response by 40% of these companies that they required more skilled maintenance men and by 21% of the companies that they had increased their engineering staffs. This indicates that automation is strengthening a trend already evident in the United States, a trend of expanding opportunity for those with industrial and professional skills and, relatively, of contracting opportunity for the unskilled.

The following chart shows how strong this trend has been over the past 25 years and how strong it may be expected to be over the next 15 years.

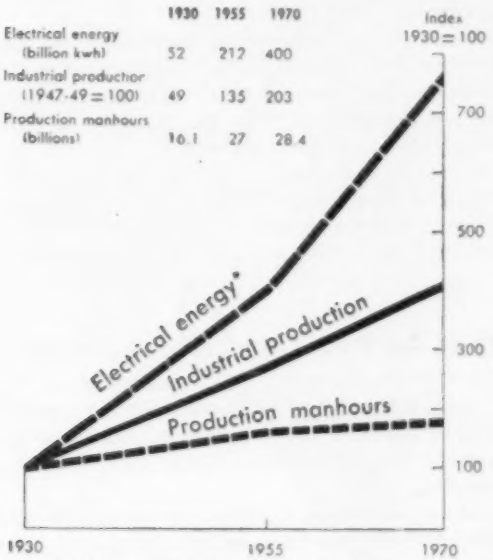
There has been a sharp decline in the percentage of unskilled workers in the nation's labor force and a corresponding increase in the percentage of those with varying degrees of skill.



It is possible, of course, to cite cases of individuals and groups that do not conform to the charted trends. Farmers, for example, are becoming at the same time more skilled and less numerous. But this does not upset the broad proposition that opportunities are increasing for those who have skills.

Power and Production

Much of the basic explanation for the relative expansion of opportunities for those with industrial and professional skills lies in the increasing use of power-driven machinery. This has made possible a vastly greater increase in manufacturing production than in the manhours of human labor devoted to it. The following chart shows the relative increases in electrical energy and manhours of labor used in manufacturing since 1930 and the rise in industrial production.

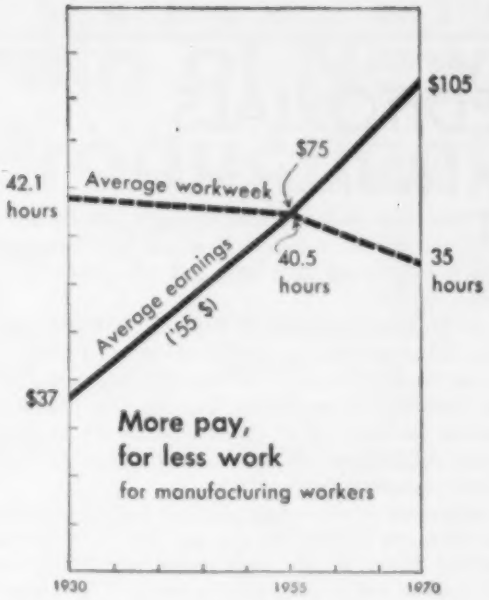


*Excludes power used in aluminum and magnesium reduction, both very heavy power users.

Power-driven machines have reduced the amount of human energy required for physical labor, but they have increased the need for skillful handling and maintenance. As the AMERICAN MACHINIST survey demonstrates, the same is true of automatically controlled machinery.

Higher Wages, More Leisure

The rising average wage of American industrial workers and the decline in hours per week that they must work reflect directly the extent to which the increase in industrial production has outstripped the manhours devoted to it. The final chart shows the increase in weekly wages (in dollars of constant purchasing power) and the decrease in the average workweek in manufacturing since 1930. It also shows the changes that may come in the next 15 years if present trends continue.



There are some who would slow what an earlier editorial in this series characterized as "the continuing process of taking dull and laborious work off the backs and minds of men and transferring it to machines operating in large batteries under automatic control." In doing so, they might make the world safer for those with no skill. The far more constructive course is to welcome the expanding opportunities now being provided and be sure that the nation's young people, who are now starting another school year, are prepared to take advantage of them.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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Donald C. McGraw
PRESIDENT
McGRAW-HILL PUBLISHING COMPANY, INC.

EDITORIALS . . .

It's a Good Place to Work

TOO often we take our employment, our livelihood, as a matter of course. Now and then it's a good idea to stop in our daily tasks and take a look at our jobs.

A. W. Scott, president of Wolf's Head Oil Refining Co., did some reflecting on that subject in a brief talk at the recent National Petroleum Ass'n. meeting. He put particular stress on the fact that the petroleum refining industry has an enviable record of providing steady employment, and that it has long had, in effect, a real guaranteed annual wage.

According to statements from the Bureau of Labor, less than one worker out of every 100 in the refining industry leaves his job each month—the lowest rate of turnover for any industry in the U.S. The figures include separations for all causes.

Five significant reasons for this were outlined by Mr. Scott and credited to William Zimmerman, Industrial Relations Director for Sun Oil Co.:

1—Demand for oil products has grown, speeded by improvements in quality, development of new products, and reduced costs that are reflected in product prices.

2—Many oil products have become necessities and are purchased on a year-around basis during good times and bad.

3—Uniformity of operation throughout the year is now achieved in the industry by building up gasoline stocks in winter and spring, and fuel oil stocks in summer and fall.

4—A relatively large amount of capital investment for each worker employed is required in the industry.

5—The oil industry is, in a sense, a huge industrial belt-line, with most of its operations carried out on a continuous 24-hour-a-day basis.

There is no "stop-and-go" about our industry. It's a good place to work.

$1,500,000 to Aid Education

WE were pleased to learn the other day that Jersey Standard and some of its affiliates have set up a new Esso Education Foundation to carry out the companies' program of financial assistance to privately-supported colleges and universities. Included in the participating affiliates are two important firms in the processing field—Esso Standard Oil Co. and Esso Research and Engineering Co.

These companies have for many years aided education by providing grants, fellowships, and scholarships for specific projects and studies of basic interest to their business. Last year, this support to education was broadened significantly by means of an experimental program of unrestricted grants to aid education at the undergraduate level. In 1954, Jersey Standard and its affiliates distributed a total of $1,000,000 in grants for educational purposes.

The Esso Research Foundation has been set up to provide a more effective instrument for continuing this educational assistance program, and has received initial pledges of $1,500,000 in contributions from the participating companies for 1955.

We have spoken a number of times in these columns of the financial problem facing this country's private schools—of their need for new income to offset rising costs and less endowment—of the responsibility which industry has to help meet this need.

Jersey's move is a good one, and concrete evidence to back up its oft-stated belief that this country's corporations, as good citizens and in their own interests, should give positive support to colleges and universities.

What Do You Know About Smog?

FLYING back from Chicago last month, we sat next to a fellow from Los Angeles. When we learned where he was from, we got into conversation with him about the then-current smog attacks his city was experiencing.

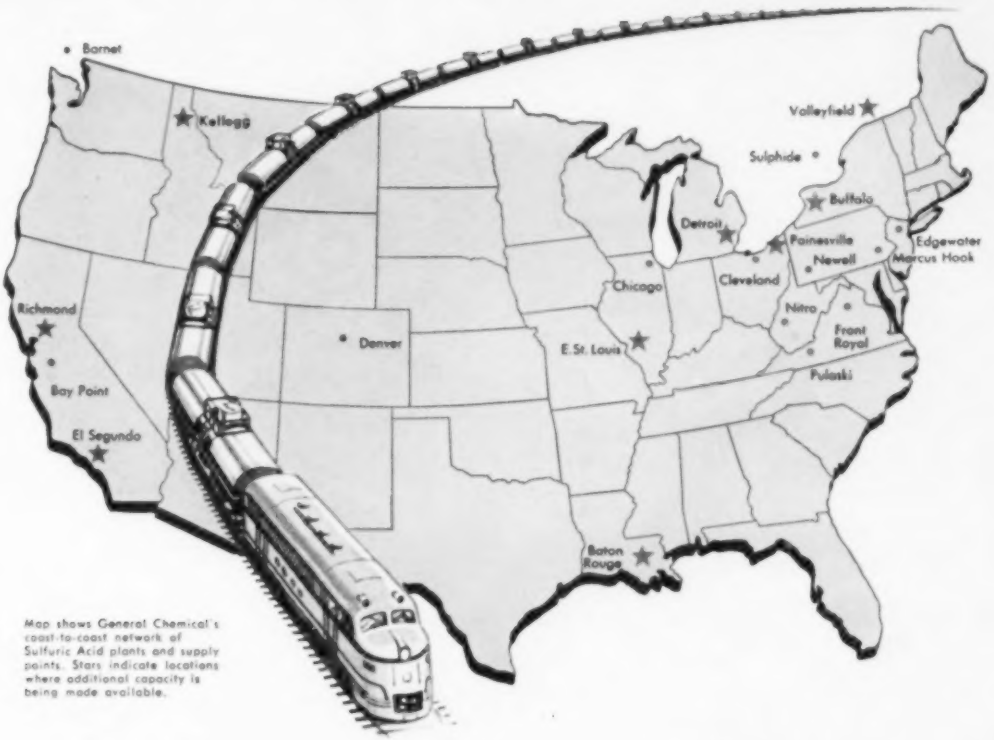
Without identifying ourselves, we asked him what caused the smog out there. His immediate reply: "The refineries and the automobiles." When we pressed him as to how those two sources were responsible, he explained that the automobiles emitted combustion products which reacted with the atmosphere to produce ozone. Likewise, he claimed, the refineries had catalytic processes which spewed similar products into the atmosphere.

He went on to tell us that the refineries were the only industry in the area, that until just the last year or so they had refused to do anything about the problem, and that they had the general attitude of "the public be damned."

We tried to set him straight with a few well-chosen facts—which maybe weren't so well-chosen, because he seemed unconvinced. His reaction was one of disbelief, tempered with the observation that the oil companies either must not have any "in" with the newspapers, or else they have a very poor public relations program.

Which leads us to the observation that the refiners in the Los Angeles area should review their public relations programs and see if they aren't missing the boat. It would seem that a realistic effort to educate the man in the street is in order—to tell him what is known about smog and its causes, and what the industry has been doing to fight the problem.

An 80-Mile Train of New Sulfuric Acid Production!



Map shows General Chemical's coast-to-coast network of Sulfuric Acid plants and supply points. Stars indicate locations where additional capacity is being made available.

General Chemical Expands Capacity from Coast to Coast!

In an expansion that extends to all points of the compass, General Chemical is providing an additional 600,000 tons of Sulfuric Acid annually, with increased production facilities . . .

- ★ **West** at El Segundo and Richmond, Calif.
- ★ **South** at Baton Rouge, La.
- ★ **North** at Valleyfield, Que.*
- ★ **East** at Buffalo, New York
- ★ **In the Mid-west** at Detroit, Mich., Painesville, Ohio and E. St. Louis, Ill.

This means approximately 12,000 more tank cars of Sulfuric Acid available to meet growing requirements of industry . . . a train load 80 miles long! Some of these new facilities are already in production, and the others are scheduled for completion in 1956.

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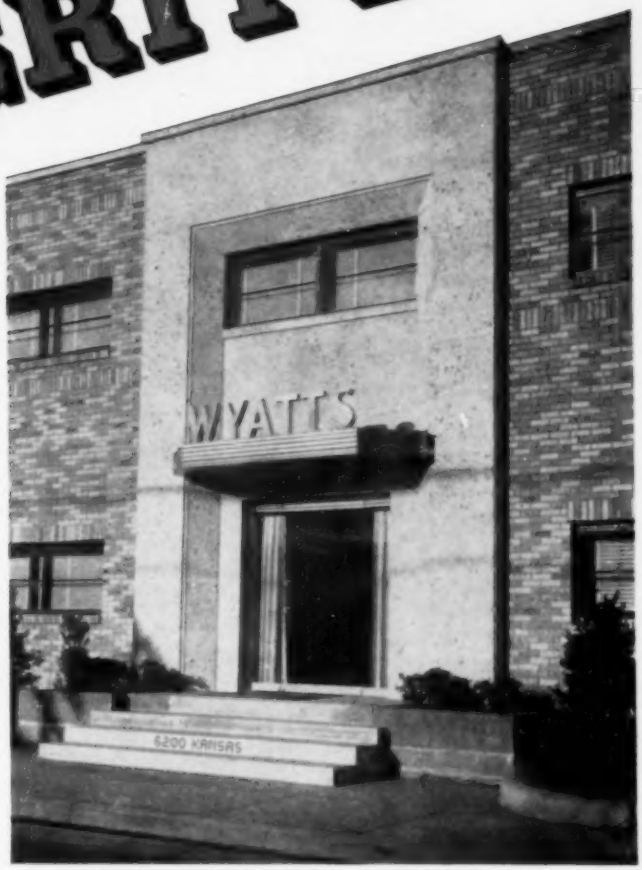

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